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Vol. XVIII—No. 3

JANUARY
1953

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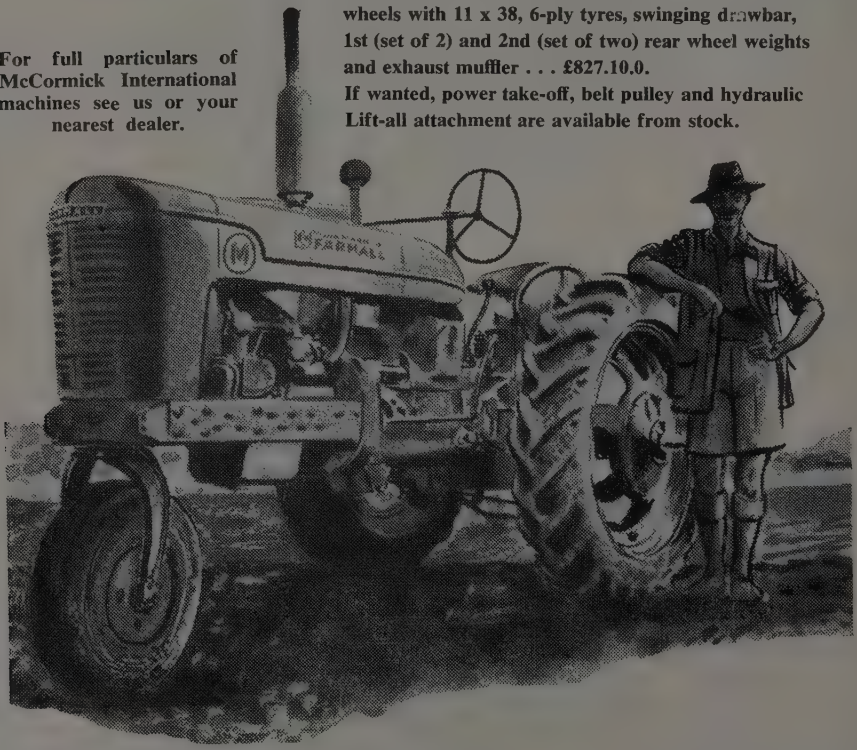

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THE

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EDITOR: D. W. DUTHIE

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Readers are reminded that all agricultural inquiries, whether they relate to articles in the Journal or not, should be addressed to the local Director of Agriculture, and not to the Editor.

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COMMONWEALTH AGRICULTURAL BUREAUX

This organization formed by the Governments of the British Commonwealth provides up-to-date information in the form of abstracting and reviewing journals, technical communications and bibliographies on all aspects of science and practice as applied to agriculture, horticulture and forestry.

Journals

The following list comprises journals and other periodical publications. Subscription rates are quoted after each; in certain cases (journal marked with an asterisk) a 20 per cent deduction is made for subscribers in the British Commonwealth who send their subscriptions direct and not through a bookseller.

	Sh.		*Sh.*
Bulletin of Entomological Research ..	40	*Plant Breeding Abstracts	35
Review of Applied Entomology (Series A)	40	*Herbage Abstracts	35
		*Field Crop Abstracts	35
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Veterinary Bulletin	40	*Forestry Abstracts	New rate undecided
Index Veterinarius	100	Forest Products and Utilization ..	10
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Commonwealth Bureau of Pastures and Field Crops, Aberystwyth

Bulletin 39.—*Five Hundred Varieties of Herbage and Fodder Crops. Price Sh.* 15, *March,* 1948.

This work brings together in the first place information received from specialists in many parts of the world on crop varieties used in the feeding of farm stock. The notes have been made to give, in as concise a form a possible, the necessary details regarding origin, adaptation, characteristics, and use of the strains in various countries, together with possibilities of obtaining supplies. Secondly, the index has been designed to supplement the first part and contains references to published information on crop varieties compiled over a period of 17 years in the Commonwealth Bureau located at Aberystwyth.

The information, which is collated in this way for the first time, will reveal not only the need for a completion of the data by the inclusion of entries from other countries, but also the desirability of some attempt being made by research workers to achieve uniformity in regard to standards, nomenclature, synonyms, etc.

Commonwealth Bureau of Horticulture and Plantation Crops, East Malling

Technical Communication No. 17.—*Chemical Composition of Plants as an Index to their Nutritional Status, by D. W. Goodall and F. G. Gregory. A Review of* 165 *pages with* 900 *references to literature. July,* 1947. *Price Sh.* 9.

Optimum nutrition is of paramount importance to plant yield. Yet the determination of the nutritional requirements of any plant is one of the hardest problems of agriculture and horticulture.

Does its solution lie in soil analysis, plant analysis, injection methods or a combination of these and other methods? The authors of T.C. 17 sift and discuss the enormous written evidence on different methods and technique and thereby do much to clear the ground for future work in this field.

All inquiries regarding these publications should go to:—

Commonwealth Agricultural Bureaux, Central Sales Branch, Penglais, Aberystwyth, Great Britain.

USE INSECTICIDES WITH CARE

Since the war D.D.T. has become a household word and it has been hailed as a miracle insecticide which will solve all our insect problems. Malaria-carrying mosquitoes and typhus-carrying lice have been controlled, and food crops have been protected against an immense variety of insect pests. The discovery of D.D.T. has been followed by the discovery of other powerful insecticides such as benzene hexachloride, Toxaphene, Parathion, Dieldrin, and many others. With all these compounds at our disposal, with their value already proved by many successes against insect pests, the belief has become current that we have emerged from our war against the insects as complete and absolute victors. However, this is a very much simplified picture and can be dangerous if people act upon it without caution. A more correct description of the value of modern insecticides is to say that used with care, and with due regard to all the factors involved, they can be immensely valuable weapons.

In any crop there is always a large number of different insects present and these may be broadly divided into two groups. There are those insects which feed on the crop and reduce its yield—the pests; and others—the predators or parasites—which live by feeding on the plant-eating insects. Over a period of time the pests and their enemies tend to balance each other. Any increase in the number of pest insects makes it easier for the enemies to find them; conversely, if the predators eat too many the pest population is reduced to such a level that they become hard to find, the predators are short of food and their numbers decrease. The population is normally in a state of balance for the operation of the natural tendency of any animal to increase in numbers brings into play a number of automatic checks which tend to reduce the population to its original level.

This natural balance in insect or animal numbers only applies in a strict sense to uncultivated land, for man, by growing a crop, many plants all of one kind in one place, has created an entirely new set of conditions which has tended to swing the balance in favour of the pests. Their favourite food is not spread as separate plants over a large area of countryside, but instead all neatly gathered in one place. Thus a farmer often finds that a pest is breeding in such large numbers that it is doing serious damage to his crop. His immediate and natural reaction is to want to spray large amounts of insecticide over every insect in sight. This is fine so long as he continues to spray, but unfortunately insecticides generally are not discriminating and kill all the predators as well. If the farmer stops spraying, the pest may often return and breed in larger numbers than ever before because many of the predatory enemies, which previously kept it in check, have been killed by the insecticide and the few survivors are in the position of a fireman trying to control a raging fire with a stirrup pump.

Under other conditions the farmer may control the original pest only to find its place taken by another. Let us take a particular example. D.D.T. is a very effective insecticide for controlling bollworms on cotton, but it does not kill the small numbers of aphids or greenfly which are usually present on the cotton at the same time. An application of D.D.T. kills the bollworm, it also kills the enemies of the aphids. The aphids which survive the D.D.T. spray breed and no longer have their numbers decimated by enemies. Ultimately freed of all checks, their numbers become so vast that they are now a pest in their own right. The bollworm has been destroyed only to be replaced by another pest equally serious, and a second insecticide has to be added to the sprays to control the aphids.

Finally, a third factor is involved in the use of insecticides. It has been found in many places that where an insecticide has been used for some time the insects have become resistant to it and the dose of insecticide that was originally enough to kill them is no longer adequate. The mechanism of this is, very crudely, as follows. Insects, like human beings, differ from each other and the dose of insecticide that is sufficient to kill one may not be enough to make another feel even off colour. If the original dose of insecticide is not quite strong enough, small numbers of the pest will survive and the next generation is bred from these more hardy individuals. Repetition of this process results in the development of a pest population very much more resistant to the insecticide.

If spraying a crop brings into play all the above factors then once you have started to spray you will not only have to continue each year but also increase the dose and possibly

buy different compounds to control any pests which have arisen as an indirect result of the use of the first compound. This does not mean that insecticides should not be used or that they are of no value, but it does mean that before any insecticide is used on a large scale careful experiments should be carried out to find the best insecticide to use and the best and safest way of using it. It should be borne in mind that insecticides are a short-term control measure and that in the end the cheapest and most satisfactory control still lies in the hands of the plant breeder and agriculturalist who by breeding resistant varieties or by changing agricultural methods will produce crops in which the insects will never be able to breed in sufficiently large numbers to make spraying worth while.

K. S. McK.

REVIEW

"The Indigenous Trees of the Uganda Protectorate" by William J. Eggeling. Second Edition revised and enlarged by Ivan R. Dale. pp. 528, 58 half tones, 21 colour plates, and map. Small Royal 8 vo. 16 x 24.5 cm. September, 1952, 42/-. Published by authority of the Uganda Government and obtainable from the Government Printer, Entebbe.

The second edition of this useful book, equally well-known to both botanists and laymen, owes the enhanced attractiveness of its appearance to the careful work of a Glasgow printing house. There are nearly 200 additional pages compared with the first edition reflecting the considerable increase in knowledge of East African trees during the past ten years.

The number of species now known from Uganda is considerably more and increased information is available about nearly all of the previously recorded species. Certain species intermediate in habit between trees and shrubs, omitted from the first edition, have now been included. Other additions include a considerable number of newly recorded native names and spot characters to the genera. The indices and glossary which were a useful feature of the first edition have been retained, but the 14 pages of feint-ruled paper headed "Notes" have wisely been omitted.

Perhaps the most noticeable difference between the two editions is the quality of the illustrations. The original line drawings, some of which are rather poor, have been retained, but other line drawings and superb coloured plates by professional artists have been added. They greatly add to the value of the work. The photographs are excellent in both editions there being several additional ones in the second.

The first edition may be unknown to some people who could make use of it and a mere comparison of the two editions will not sufficiently indicate the contents of the new book. Since it contains every known Uganda tree, keys for their identification, and citations of dried herbarium specimens (to be found both at Kew and in local herbaria at Nairobi and Entebbe) it may be claimed as a "Flora of woody plants". This alone makes it important. The only complete Flora dealing with East Africa is the Flora of Tropical Africa. This is now hopelessly out of date and has to be augmented by long runs of botanical periodicals. The Flora of Tropical East Africa has begun but will not be finished for several decades. The other works on East African trees are either incomplete or lack keys and are merely check lists and of little help to people who do not already have a considerable knowledge of the African flora. The present work will be of value to all people in Uganda and, if used with caution, to those of Kenya, Tanganyika, East Belgian Congo and Southern Sudan. The keys are not over-technical and the glossary is quite exhaustive.

The botanical nomenclature employed in a local book is not really of great importance. It should be as correct as possible with the limited resources available. Mr. Dale has carefully corrected the names used. Unfortunately whilst the book was in the press, several important Belgian and English papers have appeared and several names used in the book are now considered incorrect and there are a number of printer's errors.

Two other errors are sufficiently serious to deserve mention. The "*Diopyros* sp." mentioned on page 105 is well known to be *Drypetes bipindensis* (Pax) Hutch. The "spiders webs" on *Elaeodendron* sp. on (page 80) are the work of tent caterpillars.

This book is a worthy culmination of years of work by members of the Uganda Forestry Department and should be in the hands of everyone interested in the African flora.

B.V.

FALLOW-FARMING IN QUEENSLAND

By A. H. Savile, Department of Agriculture, Tanganyika Territory

(*Received for publication on 16th December,* 1952)

The following notes on dry-farming methods which have proved successful in Queensland have been written in order to provide food for thought for farmers and agricultural workers living in low rainfall areas in East Africa. Recently I had the opportunity of studying farming conditions in Central Queensland with particular regard to the possibility of growing sorghum or other food crops in this area of low rainfall. Past attempts at producing sorghum had been unsatisfactory, failures being invariably attributed to neglect on the part of the Providence to supply perfect farming weather. Each season's crop failures were due to such time-honoured excuses as heatwaves, unseasonal rain, insufficient rain, unusual frosts, etc. In fact after reading all these convincing reasons for man's inability to battle against such climatic odds one felt sure that the only thing to do would be to put the land down to grass and use it for cattle and sheep ranching. As we went round the country we saw thousands of acres or sorghum, some of it farmed under a quasi-Government organization, some of it grown by private enterprise, but all of it a dismal failure by any standard. Of course, all was explained by the fact that there had been an unprecedented period of dry weather and heat-waves during the proper planting season with the result that all the sorghum had been dry-sown late in the season and then there had only been six inches of effective rainfall during the growing season. It was obviously impossible to expect farmers to produce sorghum under such an erratic rainfall. We then came to a property with over 8,000 acres under sorghum. On one field known as the Boundary Paddock the sorghum might have run out at ½ cwt. per acre. On the other side of the fence in the Upper Dalwood paddock there was an exceptionally good crop of dwarf sorghum. The rain gauge at the farm homestead showed that the rainfall during the growing season had been just over six inches, which might have been sufficient to account for the failure of the sorghum in the Boundary Paddock but would not have been sufficient in itself to produce a crop in the adjacent paddock, the yield of which subsequently ranged from 7½ cwt. to 21 cwt. per acre over an area of 5,000 acres.

The cropping history of the Boundary Paddock was that it had been cropped with sorghum in 1950 and 1951. The 1951 crop had been a poor one but it had yielded a light harvest and the sorghum stubbles had been left on the land for some weeks after harvest in order to provide feed for the cattle on the ranch.

The Upper Dalwood paddock had also been cropped with sorghum in 1950 but the 1951 planting had been so patchy that the manager decided to put in the tine cultivators and run the whole 5,000 acres as a bare fallow until 1952. This was done on the advice of a young agronomist who had been taking soil moisture samples at weekly intervals down to a depth of four feet. He was convinced that the subsoil was too dry to produce a profitable crop of sorghum unless unusually heavy rains occurred. The odds were against such an occurrence and therefore he argued that it would be better to try and store the 1951 season's rainfall in the ground and utilize it for the production of the 1952 crop. This entailed keeping down all weed growth during 1951 in order to prevent losses of soil moisture by transpiration. This was done by means of duck-foot cultivators and involved three or four cultivations at a cost of say Sh. 5 per acre each—total Sh. 20 per acre, with a highly profitable crop of sorghum in 1952 instead of the usual failure due to "unsatisfactory weather".

The soils over a considerable part of Central Queensland are somewhat similar to what are commonly called "black cotton" soils in East Africa. These Queensland soils however do not harden and crack like our "black cotton" soils but develop a loose mulch on the surface when they dry out. Curiously enough they are very similar in appearance to the soils in parts of the Gedaref district of the Eastern Sudan where it has recently been found that fallowing the land in alternate years has given marked improvements in crop yields particularly in the case of sorghum.

The importance of having reserves of subsoil moisture for the ensuing crop in the low rainfall farming areas of Queensland are shown in the table below, which was extracted from the *Queensland Agricultural Journal,* August, 1951.

GRAIN SORGHUM VARIETY TRIALS

YIELD PER ACRE

VARIETY	1949	1950	1951
	Bushels	*Bushels*	*Bushels*
Alpha	39·5	30·7	82·4
Wheatland	40·0	28·4	81·4
Ajax	46·0	32·5	75·7
Capricorn	39·0	33·6	74·9
Caprock	46·7	37·1	73·2
Kalo	40·5	33·2	71·1
Early Kalo	42·1	30·2	68·6
Average of all varieties	42·0	32·2	75·3

RAINFALL	1949	1950	1951
	Inches	*Inches*	*Inches*
Planting to flowering	1·39	4·47	9·06
Flowering to maturity	14·48	10·80	1·75
Depth of wet soil at planting	54	30	45

Note.—Bushel weight of sorghum = 56 lb.

It will be seen that in 1949, when the depth of wet soil was 54 inches at planting, despite the low rainfall from planting to flowering, all varieties produced satisfactory yields. By contrast, in 1950, with only 30 inches of wet soil at planting time, the same varieties averaged only 76 per cent as much grain although experiencing over twice as much rain from planting to flowering and good rains thereafter. The value of the combination of a good depth of wet soil at planting plus a satisfactory rainfall up to the time of flowering is illustrated by the high yields obtained in 1951, despite the very low rainfall that occurred between flowering and maturity.

A further striking instance of the importance of adequate supplies of soil moisture at time of planting was illustrated by two adjacent plots on the Regional Experiment Station at Biloela. Both plots received identical cultivations and were planted with sorghum on the same date. The rainfall during growing season amounted to 1.90 inches. On one plot the depth of wet soil at time of planting was three feet and the crop was a failure. On the other plot the wet soil extended to a depth of six feet, the sorghum crop was found to have utilized soil moisture to a depth of 5½ feet and it yielded a crop of 45 bushels per acre.

On these self-mulching heavy soils of Central Queensland deep cultivation appears to be a disadvantage, as the soil dries out quickly down to the depth of cultivation, with consequent failure of the young seedlings unless the rains after planting are ideal. It is safer to carry out shallow cultivations and ensure a moist subsoil within easy reach of the young seedling.

The use of press-wheels, home-made ribbed rollers made from old motor tyres, etc., were considered to be essential if even and rapid germination was to be obtained. The use of press-wheels is particularly important where large acreages have to be planted. It has been demonstrated in the Sudan that by using press-wheels the planting period during which a satisfactory stand can be obtained can be extended by seven days, so that instead of having to cease planting after two days it was possible to go on for nine days and still obtain a good stand of sorghum. In the absence of press-wheels a very uneven germination would have resulted, and "malting of the grain" and failure of the crop due to unsatisfactory weather conditions at time of planting would be reported.

There are other factors which have to be considered in connexion with bare fallowing, notably the destruction of weeds and the improved nitrogen status of the soil. Furthermore, soils that will hold adequate supplies of moisture for a considerable period are probably less common in Africa than they appear to be in Central Queensland. Research workers in the Queensland Department of Agriculture have been working on problems connected with soil moisture and the results tabulated above are the culmination of 17 years' work on the subject. It is possible that the results obtained in Queensland may only be applicable to a limited number of soil types but it would be well worth while finding out which soil types responded to dry-fallowing methods of moisture conservation. Areas which have hitherto been regarded as too dry for crop production might be found to be suitable for farming by means of fallows in alternate years. I think it will be agreed that the whole problem offers food for thought and hopes for finding ways and means of combating the intransigence of the climate by means of improved farming techniques.

REFERENCE

"Soil Factors Affecting Crop Production in Queensland", by W. G. Wells, *Queensland Agricultural Journal*, August, 1951.

A DISEASE OF LUCERNE IN KENYA

By R. M. Nattrass, Department of Agriculture, Kenya Colony

(*Received for publication on 6th November*, 1952)

Rosellinia necatrix (Hart) Berl. is a well known parasitic fungus on forest and deciduous fruit trees in many parts of the world. It also attacks herbaceous plants and certain root crops and in the Kenya Highlands, above 7,000 ft., has caused the destruction of strawberries and Bosenberries as well as apples and almond trees.

An instance of this fungus attacking lucerne was brought to my notice during the present year. Affected plants were first seen by the farmer in 1951 and, when visited this year, the dead patches had extended over several square yards and were scattered within a few yards of each other over a broad belt.

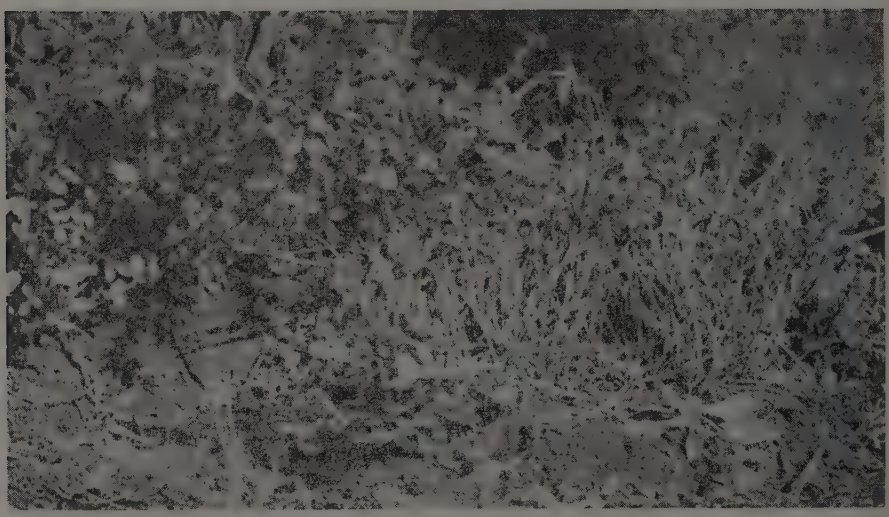
At the edges of the patches the plants were wilted or defoliated. The roots of these plants showed the appearance of typical *Rosellinia* infection, with adhering soil and white strands of mycelium. Portions of such roots kept in a moist atmosphere developed the *Graphium* stage, characteristic of *R. necatrix*.

The field was indigenous forest up to 1928 and was then cropped with maize until 1939 when it was put down to Kikuyu grass and carried stock until 1947. Wheat was grown in 1948, followed by lucerne which for the last two years has been irrigated.

It seems probable that the fungus has survived during the 12-year interval on the roots of the original forest trees.

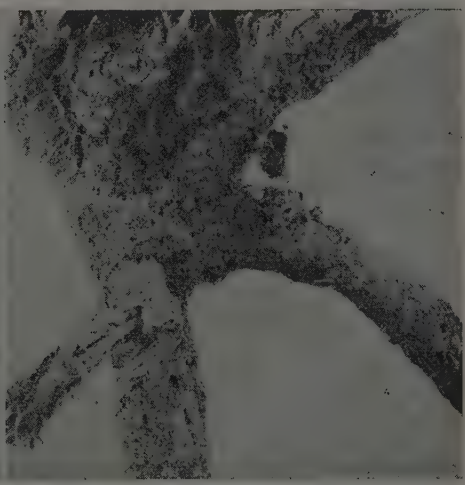
[*In February*, 1953, *the fungus was again identified on lucerne about* 100 *miles from the occurrence recorded above.*]

1. Area of lucerne killed by Rosellinia necatrix.



2. Healthy and diseased plants at the edge of an affected patch.

3. Lucerne plant in advanced stage of attack by R. necatrix.



4. Affected root of lucerne plant showing white strands of mycelium.

A NOTE ON THE RELEASE OF NEW CEREAL VARIETIES—IV

By H. C. Thorpe, Department of Agriculture, Kenya Colony

(*Received for publication on 3rd December,* 1952)

The following wheat variety has been released to farmers from Departmental control for sowing in the 1952–53 season. The new variety has been tested firstly in trial plots on the Plant Breeding Station, Njoro, and subsequently on a field scale with farmers in various parts of the Colony. It has been released through normal commercial channels. Fuller details of the procedure were given in an earlier article (1).

Wheat No. 321, *BT.*1.*B.*1

A selection out of the cross Australian 45.C.5 x 117.A made at the Plant Breeding Station, Njoro, in 1939.

321 is a beardless, white-chaffed, white-grained variety of mid-season maturity, fair straw strength and of moderate baking quality. Seedling tests show it to be resistant to the physiologic forms of black stem rust K1 to K7 and to K11; and susceptible to K8 and K9. Tests with K10 and K12 are in progress. The variety has not been attacked by stem rust in the field. It possesses resistance to orange leaf rust, and to yellow ear rust up to approximately 7,000 ft. in Kenya.

321 has done moderately well on a field scale at Solai, Njoro, and in the Moiben Valley, and should be suited to all areas of the Colony having a growing season of 5½ months' duration.

Appearance of Three New Physiologic Forms of Black Stem Rust

Preparations had been made for the release of this new wheat when three new physiologic forms of black stem rust made their appearance. The appearance of these three new rusts now makes twelve physiologic forms of black stem rust to be isolated in East Africa. K10 and K11 were isolated late in the 1950 season, K10 in Kenya, and K11 both in Kenya and Tanganyika. Subsequently, a twelfth physiologic form, K12, appeared in Kenya in 1951.

In view of the fact that 321, although susceptible in seedling tests to some rust forms, has shown resistance on a field scale it is felt it may prove of value on this account and it was, accordingly, decided to proceed with its release.

NOTE

Black stem rust = *Puccinia graminis Tritici* (Eriks. and Henn.).

Orange leaf rust = *P. triticina* (Eriks.).

Yellow ear rust = *P. glumarum* (Eriks. and Henn.).

REFERENCE

Thorpe, H. C. (1949).—"A Note on the Release of Some New Cereal Varieties", *E.A. Agric. J.*, XIV, pp. 210-211.

REVIEW

THE GRAIN SORGHUMS

The importance of this extremely large group of tropical cereals as a source of food for man and beast is now widely recognized by agriculturalists and others dealing with world food-shortages. Over large areas of Africa and tropical Asia, the grains of these plants form an important part of the diet of the natives, whilst elsewhere, especially in America and parts of Australia, they are used extensively as food for domestic animals. There are many thousands of local varieties, differing much in structure, yield and growth requirements. Their identification is difficult. It is not generally known, however, that a comprehensive survey of them was undertaken about twenty years ago, when as the result of an appeal issued in the British Commonwealth and in many other countries, several thousand flowering and fruiting heads, together with much valuable data concerning them, was received at the Royal Botanic Gardens, Kew. This material was utilized in the preparation of the book entitled "The Cultivated Races of Sorghum", by J. D. Snowden, at one time Economic Botanist in the Uganda Protectorate. In its 274 pages, this book includes not only a classification and descriptive account of the 31 botanical races and of their numerous varieties and forms, but also detailed information on their distribution, culture and economics, together with an extensive bibliography of twelve pages, indices of botanical and vernacular names, and numerous illustrations. It is a work which should be in the libraries of all agricultural officers dealing with tropical field crops, and of everyone generally interested in economic botany. Copies, in paper covers, are still available from the Bentham-Moxon Trustees, Royal Botanic Gardens, Kew, Richmond, Surrey, at the very reasonable price of 10/6d. postage extra.

THE PROTECTION OF BUILDINGS AND TIMBER AGAINST TERMITES

It is possible to arouse great popular interest in new pests and diseases, to stimulate such enthusiasm for their destruction or eradication that funds become available by popular demand. To a less extent this valuable function of novelty can be exploited with new ways to treat old pests, and suitable words like helicopter, antibiotic or isotope act as an "open sesame" to public and private funds. But old ways to treat old pests, or even new ways that lack the appeal of "modern science"—that is quite a different story. Thus it comes about that we can read in the introduction to a pamphlet published in 1950* "The need for a concise summary of existing information on the prevention and control of infestation of buildings and building material by termites has not, hitherto, been met by a publication readily available to architects, builders, forest officers and others concerned in the British Colonies".

The termites which damage the woodwork of buildings in Mediterranean countries are mentioned frequently in the Greek and Roman classics. Indian legend and Egyptian hieroglyphics both tell of the termite. While the enthusiasm of the early European traveller in the tropics knew no bounds when describing this wondrous insect, as witness Sir John Mandeville—"There inhabit certain mountains of India ants of the stature of our puppies. They dig up, purify and gather with intense industry small fragments of gold, which they take out of and put back in the mines". There is thus no novelty about the termite, especially to those who live in the tropics and sub-tropics —they probably ate the poles of the very first house built by primitive man in tropical Africa, and have continued to do so ever since.

In the present century attempts have been made by entomologists in a number of colonial territories to make known the habits of the different kinds of termites and to suggest simple, unspectacular methods of avoiding the damage that termites do to buildings and building materials. As these entomologists have been, almost without exception, employed by Departments of Agriculture, their advice has only been available to the rather limited circle of those who read agricultural journals and pamphlets. The present publication is authentic; it comes from the Forest Products Research Laboratory of the Department of Scientific and Industrial Research and the chapter on methods of construction has been prepared with the co-operation of the Building Research Station. It is a clearly written account of practical value, but it must be emphasized that it is based on common sense, good workmanship, expense on extra materials and the like, and lacks popular appeal in its neglect of "scientific" gadgets and peculiar chemicals.

"The first requisites for a successful attack on the termite problem are knowledge and the right attitude of mind." Thus the author, having devoted his first chapter to the life history and habits of termites, turns to protective measures against them. "Fatalism, which accepts termite infestation as inevitable, is no more justifiable than would be the acceptance of leaking roofs as normal building practice. There should be as much if not more concern on the part of architects and builders to make the foundations termite-proof as there is to make the roof weather-proof. Failure in the latter respect would rapidly put a builder out of business, but because of general ignorance and lack of informed public opinion there is no strong pressure brought to bear on the building trade to eliminate, or greatly reduce, termite attack." This, it should be noted, does not come from a local resident with a bee in his bonnet who may never have laid trowel to plaster. "The development of technical schools provides a unique opportunity for training architects and building operatives in the principles and techniques of termite proofing in building construction." . . . . "Very few of the British Colonies have taken legislative action to control the termite pest and some interested and experienced architects, engineers and entomologists consider there can be no real progress without some measure of compulsion." It may well be felt that compulsion is best delayed until the willing have had an opportunity to take precautions on their own initiative, reserving legislation to bring in the wilful and ignorant who may imperil the good work of the others. Such precautions are dealt with in this pamphlet under the following headings:—

1. The eradication of termites from building sites, buildings and infested wood.
2. The use of resistant or treated timber and other building materials.
3. Methods of building construction to prevent infestation.

* "The Protection of Buildings and Timber against Termites." W. D. MacGregor, C.B.E., B.SC., Department of Scientific and Industrial Research. Forest Products Research Bulletin No. 24. 1950. H.M.S.O. 1/9*d*.

Briefly, for this after all is a one and ninepenny pamphlet not a large tome, methods are given for treating the building site with chemicals likely to destroy or chase away termites. The destruction of colonies in large mounds in or near the building site is next dealt with, and finally reference is made to the destruction of termites which have appeared in a building after it has been erected

A chapter is devoted to timber which is naturally resistant to termite attack, and to other timber which has been made so by the efficient use of chemical impregnation. An appendix of indigenous timbers reputed to be resistant to termites" is given and which is of considerable practical use since it is divided into lists for each colony and gives local names for all the timbers. Referring to chemical impregnation, the author states "the preservation of timber depends more on the way the preservative is applied than on the particular preservative, assuming, of course, that the materials are up to toxic standard. Permanent protection requires sufficiently deep penetration to ensure that untreated wood will not be exposed by splitting, cutting or abrasion, and also to provide for a reserve of preservative against losses from surface leaching". Four types of impregnation are listed—surface treatment, steeping treatment, hot and cold open tank treatment, and pressure treatment. The hot and cold open tank method is recommended as a practical proposition for the builder who cannot obtain pressure-treated timber. Surface treatment is written off, quite properly, as being suitable only where temporary service is required. "The use of paint, as a protection against dry-wood termites, requires consideration . . . it is not a practical measure against subterranean termites because they enter the concealed parts of wood which are rarely painted".

The concluding chapter on methods of construction is illustrated by a number of figures which show clearly the building operations involved in the recommendations. Termite barriers are discussed, and reference made to the particular problems of cavity walls. The need for providing facilities for the regular inspection of buildings is emphasized, and, it might be added, this has to be thought of in the planning stage and not when the building is half way up. Cracking is another practical problem for which suggestions are made. Finally there are two lists of practical notes, the one for use where there are subterranean termites, as in East Africa, the other for where there are dry-wood termites. Any tendency to dismiss these notes as mere statements of the obvious can be corrected by a visit to almost any building site in East Africa.

A selected bibliography is given for those who would read in greater detail about the termites which damage buildings in their own particular part of the world, or who are interested to discover what is being attempted elsewhere. As an introduction to the practical problems of protecting buildings and timber against termites, Mr. MacGregor's pamphlet can be recommended to all who wish seriously to do something about it.

W.V.H.

TREE-PLANTING IN TANGANYIKA

I. Methods of Planting

By M. S. Parry, Forest Department, Tanganyika Territory

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The object of this article is to summarize briefly the available information about the species of trees most commonly planted in Tanganyika, and to describe the methods used, primarily for the guidance of the amateur tree-planter. Accurate information about the great majority of species is surprisingly difficult to come by, and it is hoped that the many omissions and inaccuracies in the present text may encourage its readers to record their own observations on the behaviour of exotic and indigenous trees planted under local conditions. The Forest Department of Tanganyika is anxious to receive and collate any information relating to growth rates, silvicultural characteristics, methods of planting, yields per acre, etc.

For the purposes of afforestation, three major climatic zones may be distinguished:—

Temperate Zone: This is taken to include the entire range from the very high rainfall areas at fairly low elevations (e.g. Amani with 80 inches of rain at 3,000 feet), through the fairly wet areas at medium elevations (e.g. Lushoto with 45 inches at 4,500 feet) up to the very high but drier areas (e.g. North Kilimanjaro with 30 inches at over 6,000 feet). It also includes the Southern Highlands areas with fairly high rainfalls (e.g. 40–60 inches) but with a long dry season, at elevations above 5,500 feet.

Coastal Zone: With rainfall about 40 inches per annum and altitude less than 2,500 feet.

Dry Zone: With rainfall less than about 35 inches per annum and altitude mostly between 2,500 feet and 4,000 feet.

There is a good deal of overlap between the zones—in particular, most species that will grow in the dry zone will grow better in the coastal zone—but the broad divisions form a convenient basis for classifying species according to their climatic requirements. In mountain areas the existence of "mist-belt" conditions, indicated by trees being festooned with lichen, greatly ameliorates the severity of a low rainfall.

In high rainfall areas most species of trees are tolerant of a wide range of soils provided the soil is not too shallow nor subject to water-logging. In dry areas the growth of trees is much more dependent upon soil type, particularly in regard to its position in the sequence from top to bottom of a slope. Very few trees will survive in the black, cracking, "mbuga" clays, which occur in the bases of flat depressions, but good growth can frequently be obtained in deep pockets of red loamy soil around the base of kopjes, on seepage zones where the lighter soils run out over an impervious clay or hard pan, and on alluvial strips alongside watercourses.

In general, the European idea that trees should only be planted on land unsuitable for agriculture, cannot be applied in the tropics, except in so far as the land may be unsuitable for crops only because the slopes are too steep. Usually, a soil which will not even support native agriculture will not be suitable for trees. An exception to this is the use of pines, etc., for the afforestation of high altitude grasslands.

The depth of soil is particularly important, and the final height of the trees is often closely correlated with rooting depth. It is difficult to lay down any specific requirements, as the rooting depth of a soil can not always be judged in advance. Good growth may be obtained on an apparently shallow rocky soil owing to roots penetrating into fissures or crevices, and, conversely, the apparently deep "hard pan" soils of the Lake Province are so impervious, as to be most unsuitable for afforestation. It is probably safe to say that at least two feet of soil over an impervious layer is the minimum requirement for satisfactory growth, and four or five feet for optimum growth.

Soil preparation.—Where trees are to be planted close together to form plantations it is usually best in the long run, particularly in dry areas, to cultivate the ground completely over the whole area as though for an agricultural crop. The initial cost is high, but this technique has the double advantage, firstly of

giving a real check to weed growth right from the start, and secondly, of enabling the cost of the work to be offset to some extent by planting a food or cash crop between the rows of trees.

This is the basis of the so-called "taungya" or "shamba" method of afforestation, whereby native squatters plant trees with their crops in return for the use of the land.

Where the "taungya" system is impracticable, soil cultivation may be concentrated only on the spots or lines where the trees are actually to be planted or sown. In this case it is difficult to over-emphasize the importance of really thorough working of the soil which should be loosened to a depth of at least 8 inches, and preferably more. It is not usually sufficient merely to scrape a circle clean and plant a tree in a small hole in the middle. "A hole the size of a debe" (a 4-gallon kerosene tin) is a good description to give to a native supervisor. For planting ornamental trees it is often worthwhile to dig an even bigger hole and refill it with topsoil. Similarly, if it is proposed to sow seed direct along ridges the ground under the ridge should be broken up first. If soil is merely scraped together from either side, the taproot is likely to be checked by the unbroken soil below. Breaking the subsoil assists the percolation of rain and allows the tree to get its roots down quickly. Rapid establishment may make the difference between success and failure if the season is broken by dry periods, and subsequent costs of weeding are reduced on account of the increased rate of growth.

Under optimum conditions, with species that are easy to establish, it is possible to get away with much less elaborate techniques, such as the planting of Teak from "stumps", or Cypress species from bare-rooted transplants. It is, hwever, unwise to rely on simplified methods until the local conditions have been thoroughly understood.

Choice of Species.—This can only be done by the individual tree planter balancing the pros and cons of each species according to his requirements and local conditions. The detailed list of species which will be given in a later article attempts to summarize their most important characteristics, and gives the method of planting usually adopted for each.

Seed Collection.—The seed of many useful species can most easily be obtained by collecting from local trees. Small stocks of many exotics are kept by the Amani Nursery, Amani, and by the Forest Department Silviculture Section at Lushoto, but for larger-scale afforestation, the most convenient source of exotic seed is the Department of Forestry, Pretoria, South Africa. Seed should always be collected from healthy, well-shaped trees; never from stunted, low-crowned trees whose branches are usually more accessible.

Direct Sowing

A number of species can be planted by sowing the seed direct into the prepared soil of the plantation area. This technique does away with the necessity for a nursery and is ideal for the establishment of fuel and pole plantations with well-tried species such as *Cassia siamea,* or Black Wattle or for species such as *Acacias,* which do not transplant easily. As a rule, species suitable for direct sowing must be fast growing, and must have large seeds, which germinate rapidly, and are obtainable in quantity. The usual but probably the least successful method is to prepare spots at the required spacing by clearing a circle 3–4 feet in diameter, and working the soil in the centre to the required depth. Half-a-dozen or more seeds are then sown near the centre. The depth of sowing is important. For nursery work, under shade the usual advice is to cover the seeds with a layer of soil equal to their diameter, but it is usually advisable to sow deeper than this in exposed places, because the surface of the soil is liable to dry out between showers. It is never wise to sow very deep, particularly with species in which the seed coat is carried up into the air with the young shoot. This method is cheap but often ineffective. It is seldom satisfactory where grass competition is severe.

If the plantation has been completely cultivated with a view to planting crops with the trees the best method is to sow the seed in lines along ridges. The ridges should be arranged on the contour, and joined at intervals by "tie-ridges". A convenient arrangement is to work the soil up into ridges at 4 ft. spacing, trees and crops then being sown on alternate ridges. The advantages of "tie-ridging" over flat cultivation in dry areas liable to intermittent heavy storms have been repeatedly demonstrated with agricultural crops, particularly cotton. It offers the best means of ensuring that every drop of rain is absorbed where it falls. With flat cultivation a large proportion of the rainfall is lost as runoff. The double-working of the soil caused by hoeing

and ridging in two separate operations is, incidentally, about the most efficient way of checking grass growth from the start.

Line-sowing also normally results in a more even spacing of seedlings in the first year as it is unusual to find a gap of more than a few feet in the lines. With "spot" sowing, the failure of two or three adjacent spots produces a large blank area, which has to be filled up next season. As against this, however, seed sown on ridges is more likely to dry out if the rains are intermittent. This risk can be reduced by making the ridges flat, or slightly concave on top. Once established, seedlings almost invariably seem to grow faster on ridges than on the flat but it is not easy to say whether this is due to the greater depth of porous soil beneath or to the reduction of weed growth caused by disturbing the soil twice. These remarks apply especially to dry areas. If the rainfall is good and well distributed, tie-ridging is unnecessary but it is best to build low ridges 8 ft. apart as a means of demarcating the lines.

Direct sowing is easiest in light sandy soils, which are ideal for germination. In heavy clays germination is often patchy. Repeated sowing at frequent intervals should be done throughout the first season until all blank areas are fully stocked. Subsequent tending operations are described later.

Nursery Technique

The seed of many useful species is unsuitable for sowing direct in the plantation on account of its small size, uncertain viability, slow initial growth, or scarcity. In this case seedlings or transplants must be raised in a nursery. The usual sequence of nursery operations may be summarized as follows:—siting and preparation of beds; sowing; transplanting; hardening off; planting out.

Siting and Preparation of Beds

The nursery must of course be sited as close to the plantation area as possible, especially if potted plants are being raised, and a plentiful water supply is essential. In dry country about one gallon per square yard per day is likely to be required. The soil should for preference be a light, sandy loam, not a heavy clay, as seeds germinate much more easily in light soils. Avoid soils which tend to form a "crust" on the surface.

If boxes or pots are used the quality of the soil in the nursery is not so important, as all the soil will be imported in any case, but it may still be necessary to take steps to ensure that fertile soil is available from forest clumps or by making compost. This is particularly important when raising Pines which need a rich humic soil in the early stages to stimulate mycorrhizal development. When the nursery soil itself is used, fertility must be maintained by any of the usual agricultural methods, e.g. rotation with legumes, composting, etc. Many forest nurseries however are temporary and are moved when the immediate vicinity has been planted.

The most convenient arrangement is to prepare long beds about 4 ft. wide raised a few inches above ground level to prevent waterlogging. The beds should normally lie east-west in order that the soil will remain shaded throughout the day as the sun passes overhead. If the nursery is on a slope, beds should be aligned on the contour and terraced. Shades are usually constructed at a height of about 4 ft. from the ground, i.e. high enough for a watering-can to be used beneath them, and may be built of grass, banana fronds, or any other material, supported on a framework of poles and withies. In permanent nurseries it is a great convenience to have properly-made shades in the form of mats, or withies tied together, which can be rolled up and removed as required. They are supported on long horizontal poles or tightly stretched wire which need only be about one foot from the ground as the shades can be removed for watering. Paths of adequate width should be left between the beds, and the variation in the sun's position throughout the season usually makes it necessary to make the shades wider than the beds, to prevent the sun from shining in sideways. If there is no shortage of poles, it is often convenient to build complete overhead shades about 6 ft. high, over the whole nursery. In dry areas this makes it easier to keep the atmosphere of the nursery cool, and less arid, and is very pleasant to work under. The beds can also be placed closer together, which is sometimes a help in saving space if it becomes necessary to take drastic action against termites or other pests by overall gammexane treatment. Seed, even small seeds, can be sown beneath overhead shade in the dry season but if rain is likely to occur, seed should be sown with a surface mulch but without shade owing to the danger of drip damage below high shade.

In mountain areas it is possible to dispense with permanent shades entirely. After transplanting, spays of bracken can be stuck in the

bed for a week or two, or if boxes are used, they can be moved temporarily under the shade of a tree.

Sowing

Before sowing, the soil should be worked to a fine tilth, and all weeds removed. If small seed is being sown, e.g. *Eucalyptus* seed, the bed should be levelled off carefully and covered with a layer of sifted soil. After sowing, the seeds should be just covered over by sieving more soil over them. With large seeds sieving is unnecessary.

Seed may be sown either in drills, i.e. in lines spaced a few inches apart, or broadcast by scattering it evenly over the whole bed. If sown in drills, shallow grooves are first made across or along the bed, spaced about 4 in.-6 in. apart; seed is sprinkled along the groove and covered over by hand. The advantage of drill sowing is that it facilitates weeding and lifting the seedlings if they are all to be transplanted at once. With some species, however, the seedlings grow unevenly and it may be necessary to pick out the largest for transplanting first. Broadcast sowing usually simplifies this operation by spacing the seed more widely. Similarly, if the seedlings are to be left *in situ* for "stump" planting, broadcast sowing is preferable. If *Eucalyptus* seed is broadcast, the small seedlings are often difficult to weed. In this case it is better to water the beds for some days before sowing in order to stimulate the germination of any dormant weed seeds. These are then removed, and the tree seed sown.

A very common practice in South Africa, with Pines and *Eucalyptus* is to sow the seed in small boxes, of the same kind as used for transplanting. The boxes are very convenient to handle and can easily be moved about, or raised up on a staging to get them away from rodents or insects. It is also very convenient to be able to lift them on to a bench for transplanting.

Rate of sowing.—The optimum rate of sowing, i.e. weight of seed per unit area of seed bed, depends upon the size of the seed, ease of germination, and efficiency of the nursery technique. As a very rough guide, it is usually not possible to lift more than 15-20 large, non-coniferous seedlings from one 4 ft. drill (i.e. about 100-150 per square yard), without seriously disturbing the roots, hence a large enough area should be sown to raise the required number of seedlings plus a fair margin for error, on this assumption, if it is considered advisable to keep the roots intact on transplanting. Usually this is only necessary in very dry country.

A much higher number of seedlings per square yard can be obtained in the case of most conifers, the roots of which can usually be separated from each other quite easily, provided the soil is friable. For example British nursery practice is to raise about 300-600 conifer seedlings per square yard, and lift them by pulling out of loosened soil.

In South Africa it is standard practice to sow Pine or *Eucalyptus* seed in small 10 in. x 8 in. boxes at such a density that up to 1,000 seedlings are lifted from one box. This is equivalent to a density of about 15,000 per square yard. At this density transplanting must be done as soon as possible, that is, when the main root has just begun to form lateral roots. It is also advisable to take precautions against the risk of "damping off", by sowing only in dry weather, using the minimum of shade or none at all, and watering with a very dilute (pale pink) solution of potassium permanganate. Species such as *Pinus patula* which are very liable to damping off cannot be sown with safety at this density, and a maximum of 300 seedlings per box is usual. In the writer's opinion the most satisfactory method with Pines, Cypresses, and Eucalypts is to sow much less thickly than the above but to transplant as soon as possible, when the root has produced only one or two stumpy branches. The cost of seed is negligible in proportion to the cost of planting hence, when sowing, it is wise to err on the side of generosity. The use of stale seed is always a false economy.

The germination of very small seeds, such as those of *Eucalyptus*, is very dependent upon the amount of care taken. One can only recommend extreme care in preparing the bed, and in sowing and watering. The seed of most species of *Eucalyptus* averages from 100,000 to 500,000 per pound, but with normal nursery practice without special care, only 10,000 to 20,000 plants are usually obtained from a pound of seed. The method of sowing in carefully prepared soil in boxes, with high rates of sowing, usually gives a higher percentage germination. It can be recommended except for very dry areas where it may be advisable to sow thinly and transplant each seedling with as much soil as possible.

The above figures are quoted as a very rough indication of normal practice, but commonsense is usually the best guide.

Time of sowing.—It is very desirable to raise plants which are of fairly even size, and are about the right height at the time of planting. The ideal height for planting is usually said to be about 8 in., but there is a growing tendency to use larger material. As a rough guide it is usual to sow most seeds in temperate altitudes about 6-8 months before the time of planting. *Eucalyptus* species require rather less, and *Pinus* species especially *P. patula* appreciably longer. In hotter regions, given adequate watering less time is required. Exceptionally fast-growing seedlings, such as those of *Afzelia, Gmelina, Cedrela, Delonix, Samanea,* and certain *Eucalyptus* spp., e.g. *E. rostrata,* can be raised in about 4 months, provided there is no check on transplanting. For "stump" planting most species need 10-12 months, unless they are raised direct from seed without transplanting, in which case 6-8 months may be adequate. Rate of growth depends to a large extent on the fertility of the nursery soil, and another variable factor is the extent to which the seedlings check on transplanting. *Eucalyptus* species are particularly variable in this respect, and therefore need very careful handling.

Transplants "lined out" in a bed grow much faster than those in boxes, pots, or undercut beds and this must be allowed for when sowing.

Watering.—After sowing, the seeds must be kept moist by watering morning and (if necessary) evening. Rain or mist will reduce the requirement. It is important to avoid overwatering, as seeds require plentiful aeration as well as moisture. Another danger to avoid in the case of small seed is damage either from rain drip, or from "washing out" of the seed owing to the use of too coarse a spray when watering. *Eucalyptus* seed in particular needs to be watered with a very fine spray. A suitable watering-can can be made by an African tinsmith. It should have a long spout (about 2 ft. 6 in.) and a "rose" of very fine holes. The purpose of the long spout is to provide a good head of water sufficient to force water through the fine holes. With a short spout insufficient pressure is built up behind the "rose" and water tends to ooze through the holes instead of squirting. When the can is standing upright, the "rose" should be level with the top of the can.

Mulching.—Drip damage, "washing out" and compacting of the soil can be rduced by covering the seed-beds with a mulch consisting of a layer of grass about ½ in.-1 in. thick laid on the surface of the beds. The mulch absorbs the impact of heavy rain or spray from a watering-can, and also helps to retain a moist atmosphere in the soil surface. If a mulch is used the beds should not be shaded. As soon as germination begins, the mulch must be removed, as there is a danger of seedlings becoming etiolated or "damping off" when covered by grass. When the mulch is removed the beds should be shaded. It is often beneficial to apply a light mulch to transplant beds or boxes. The mulch has a remarkable effect in preserving moisture. It also prevents caking of the surface, and sun-scorch around the collar of the transplant.

Transplanting

The objects of transplanting in a nursery are, firstly, to arrange the seedlings at an even spacing, giving each one room to develop without competition from its neighbours, or to transfer them to a receptacle in which they can be transported, and, secondly, to check the development of a deep tap-root and stimulate the formation of fibrous roots near the surface. Transplants can nearly always be planted out with greater success than seedlings. Before transplanting difficult seedlings, such as *Eucalyptus* it is wise to harden them off for a week or two beforehand, by progressively reducing shade and watering. This is unnecessary in the case of seedlings which transplant easily, such as those of most conifers, e.g. *Cupressus,* or *Pinus* spp. but nothing is gained by overshading, and it should always be a golden rule to use as little shade as possible.

Seedlings are usually transplanted when 2 in.- 2½ in. high, but if high sowing rates are employed giving densities of several thousand per square yard it is essential to transplant when the seedlings are 1 in to 1½ in. high, i.e. when the root has begun to form laterals, but the side roots have not become very much intermingled. Early transplanting is very quick and easy and should be practised whenever possible. There are a few species which do not transplant easily when very small but these often need special care in any case. With most species nothing is gained by postponing the operation. Large seedlings suffer greater shock, and are more likely to be planted badly by unskilled labour.

Seedlings should always be held by the leaves only, never by the stem. The main root should be chopped off cleanly to a length of about 2 in. to 3 in., depending on the size of the plant and not allowed to become coiled up. After planting, the seedling should be embedded in the ground to the same level as it was before, or perhaps a little lower, and the soil pressed firmly around the roots. In very dry country, it may be advisable to lift the seedlings together with a compact ball of moist earth, and transfer them together with the soil to the pots, or boxes into which they are being transplanted. For this purpose seedlings should be raised at a wide espacement by sowing thinly.

Mycorrhiza.—The various species of *Pinus* (the Pines) and a few others, including *Casuarina* and *Robinia* habitually develop branched structures on the roots known as mycorrhiza. These are closely associated with a particular fungus, and appear to be essential to the proper nutrition of the plant. If the fungus is not present, the trees remain stunted and yellow. When planting Pines in a new locality therefore it is essential to "inoculate" the soil in which the transplants are raised by incorporating with it a quantity of topsoil containing roots, taken from an established pine plantation. At least 10 per cent by volume is required for safety. The mycorrhizal soil must be kept moist during transport or storage, and should not be broken up too much. It should be used as soon as possible after being taken from the plantation. Mycorrhizal deficiency has caused a great deal of trouble in Tanganyika owing to the difficulty of getting large quantities of suitable soil transported to new areas. The trouble can be reduced to some extent by raising the plants in a very fertile soil consisting largely of forest topsoil containing about 5 per cent of cattle manure. Phosphate at the rate of about 4 ounces per square yard is also beneficial, but these measures are usually not a complete substitute for inoculation. The difficulty is usually worst in dry areas.

The various types of transplant may be classified as follows:—

Transplants with naked roots.—The simplest method, suitable only for easy species, such as *Cupressus,* planted under moist conditions. The seedlings are simply "lined-out", i.e. transplanted to a spacing of usually 4 in. x 4 in. to 6 in. x 6 in., arranged either in beds, or in "brakes" which are simply flat areas of the nursery with narrow paths of access. Transplants in "brakes" are frequently not shaded, nor watered if rainfall is adequate. On planting-out, the transplants are puddled and lifted with as much root as possible, but the minimum amount of soil. They are packed closely in trays, so that one man can carry a large number. As most of the root system is inevitably left behind in the nursery this method can be recommended only for optimum conditions.

Transplants in balls of earth.—These are lined out in similar fashion to the above, but at the time of planting the plants are lifted with as much soil as possible adhering to the roots. As the plants can obviously not be carried far without losing all the soil, the method is suitable only for small-scale planting close to a nursery, where boxes or pots are not available.

Transplants in boxes or trays.—The seedlings are transplanted into wooden trays about 5 in. deep, and small enough for one man to carry when filled with earth. Half petrol-tins cut lengthways are sometimes used also. The trays are carried right into the plantation at the time of planting, and the plants lifted carefully with as much earth as possible adhering to the roots. An advantage of planting in boxes is that the roots are unable to penetrate to any depth, and a mass of superficial roots is produced. The plants need longer in the nursery but are much more reliable.

For the sake of economy in boxes and transport, the plants are always spaced closely together in the trays, usually either at 2 in. x 2 in. or at 1½ in. x 1½ in. The closer spacing has been found perfectly adequate unless conditions are marginal provided a really fertile soil is used, and as it effects an economy of almost 50 per cent, it has everything to recommend it. In dry places, however, or for small-scale work, the wider spacing is preferable as the plants tend to be more uniform and can be planted with very little disturbance to the roots. A box 16 inches square is a convenient size and holds 100 plants (or 49 at the wider spacing). The quality of soil used to fill the box is important as the roots have only a very small space in which to develop. The best filling is the friable, humic topsoil taken from beneath dense forest. Failing this a mixture of ordinary sifted soil and bush topsoil, with a small quantity of compost or manure, is very suitable. A bottom layer of gravel charcoal, or other free-draining material is advisable, to prevent waterlogging.

The boxes can be made from any soft-wood or scrap timber, the best being Pencil Cedar which is very durable. Other soft timbers will only last for a year or two unless they are dipped in molten tar. Creosote can also be used, but is liable to be toxic if present in large quantities. Care must be taken to ensure that there are gaps between the bottom slats even when the box is soaked, to allow for drainage.

This method of planting is the one commonly adopted for large-scale afforestation with *Pines* and *Cypress*, and can also be used for *Eucalyptus*. If Pines are being planted the soil must be "inoculated" with mycorrhizal soil.

"Swaziland technique".—A modification of the above box technique is being used on a large scale in Swaziland for Pine planting, and is now being adopted in Tanganyika. Its purpose is to economize on the number of boxes required, while giving the same advantages.

The seedlings are transplanted into a long bed, 3 ft. wide, at the usual spacing of 1½ in. x 1½ in. or 2 in. x 2 in. The bed, however, is built up of an imported soil mixture as used for filling boxes. The outline of the bed is delimited by bricks, cement blocks, or wooden baulks, which are about 5 in. deep. The space so formed is filled up nearly to the top with the imported soil as though it were a large flat tray. The whole bed rests on a flat surface of hard subsoil. After transplanting the roots are pruned at least once a week by drawing a length of steel piano wire along underneath the bed as though it were a flexible saw. In the absence of piano wire it is possible to use the thin strands which can be obtained by unravelling certain types of steel cable. This can often be picked up on scrap heaps around garages, sawmills, etc. The thick strands are not suitable. During the root cutting operation the bricks or wooden baulks enclosing the bed remain in place and hold the wire down to the right level. Two men can perform this operation very quickly once they have got the knack.

At the time of planting the surrounding bricks or baulks are rolled away and the bed can be "carved up" into small sections each about the size of a standard planting box. The soil is bound together by a mass of fibrous roots, and these small sections can be lifted on a spade and dropped into a box without disturbing the roots, and even without removing one side of the box. The chief advantage of this method is that it effects an enormous saving in boxes as each box can be used several times over during the planting season. In practice it has been found that a saving of 80 per cent can be obtained provided there are good communications between the nursery and planting area. Moreover the boxes last indefinitely, even if they are not treated, being used only for a few weeks every year. The chief drawback to this method is that it is impossible to dump all the nursery stock in the planting area at the beginning of the rains to await favourable planting weather. The plants have to be transported just at the time when communications are at their worst.

Pot planting.—The advantage of transplanting each seedling into its own individual pot is that the plants can later be planted-out with a considerable quantity of soil and practically no disturbance to the roots. The method is very suitable for planting species which are difficult to transplant, especially in dry country, and is very widely used for the planting of *Eucalyptus* species. The pots have to be moved occasionally to prevent the roots from penetrating through the bottom into the soil below. At the same time the oportunity can be taken to sort the plants according to size so that the largest can be planted out first, leaving the laggards for filling up blanks later. The usual objection to pot planting is the high cost, due not only to the cost of the pots, but also to the cost of transporting them to the plantation. On the other hand, in some places, where material is abundant, pot planting is cheaper than planting in trays, owing to the high cost of timber or petrol tins.

Whatever type of pot is used it is very desirable to fill them with a good loamy soil. The soil should not be too sandy or it will run through the bottom, nor to heavy, or it will compact and bake to a brick-like core. When planting fibre pots it is advisable to remove as much of the fibre as possible if there are termites about. It is also very necessary to press the soil very firmly around the roots, otherwise the core of soil that was in the pot is likely to separate away from the surrounding soil during dry spells, and leave a gap which the roots cannot grow across.

Owing to the difficulty of transplanting some seedlings, the technique is sometimes adopted of sowing seeds direct into the pots. This shortens the time in the nursery by avoiding the inevitable check caused by transplanting. It is, however, not always very easy to secure germination in every pot, unless a fair number of seeds are sown per pot, and the seed is fresh.

The conditions recommended above under "Sowing", particularly with regard to a fine tilth and watering, should be reproduced as far as possible when sowing in pots.

The types of pots most commonly used are described at the end of this article.

"Stump" planting.—Many trees are capable of sprouting vigorously when cut back almost to ground level. If the root system also has the ability to develop rapidly again, when pruned, the species is suitable for "stump" planting. Stumps are obtained by lifting young trees when they are about ½ in. in diameter at the base, and usually 4-6 ft. high. The shoot is cut right back to about 1-2 in. above the ground level, and the main root is pruned to about 8 in. to 10 in. below ground level. Small fibrous roots are cut off cleanly. The stump which results is very easy to pack, transport and plant, and is frequently less sensitive to dry spells than a seed or transplant, because the roots tend to develop from the base of the stump, i.e. at 8 in. to 10 in. depth, and the absence of leaves reduces the plant's consumption of water. Care is needed to prevent bruising of the stumps when they are being packed for transport. They must of course be planted with the soil at exactly the same level as it was originally.

Stumps may be obtained from overgrown seedlings raised by sowing the seed at a wide espacement. This is the usual procedure for raising Teak stumps, as the seedlings do not suffer when crowded together, but with most species it is preferable to transplant the seedlings, when 2 in. to 3 in. high to a spacing of about 8 in. x 8 in. to give each plant adequate room to develop. This produces a more uniform batch of plants. There is an optimum size for stump planting but it is not usually very critical. A diameter of ½ in. to 1 in. is about the best compromise. Smaller stumps are less successful and larger ones more expensive. Most species require from 6 to 12 months to reach an adequate size for stumping. Stumps appear to strike most easily in moist, sandy soil, and will not grow well in heavy clay. Coniferous species cannot be planted from stumps.

"Striplings".—The term "stripling" appears to have originated in Uganda, and is applied to very large transplants, usually 6 ft. to 8 ft. high, from which all the leaves are removed before planting except a few at the apex. The plant is dug up and the main roots pruned to a length of about 12 in. The use of striplings was developed primarily as a means of overcoming the difficulties encountered when planting Mvule (*Chlorophora excelsa*), which is very susceptible to damage by buck, and is attacked by a gall infestation in its young stages. Other species, such as the Uganda Mahoganies, (*Entandrophragma* spp.) and *Maesopsis eminii*, have also responded to this technique, which is suitable mainly for improving natural woodland in fairly moist areas by under-planting with indigenous species at a wide espacement.

Striplings are raised in the nursery by transplanting seedlings when they are 12 months old to a spacing of 2 ft. x 2 ft. where they remain for a further 2 months. They are expensive to raise, and clumsy to transport, but this objection is not insuperable when only about 50 are needed per acre planted. For an account of the Uganda methods see the Empire Forestry Review, Vol. 28, No. 3 September, 1949 ("Timber planting in the Terminalia woodlands of N. Uganda" by H. C. Dawkins).

Cuttings.—A few species strike very easily from cuttings and it may be simpler in some cases to obtain a stock of plants by lining out cuttings, rather than by raising seedlings, particularly if seed is difficult to come by. Cuttings strike most easily in moist sand, and can be induced to form roots more readily by the use of proprietary hormone compounds, but this method is more applicable to horticultural work than to large-scale afforestation. A few indigenous trees can be planted easily by means of large cuttings in the form of stakes 3 ft. to 6 ft. long which are simply planted like fence posts werever they are wanted. Most large Fig species are planted this way and also the common plants used by Africans to make live fences, such as the native *Commiphora* species, and the wild Flamboyant, (*Delonix elata*). Mninga (*Pterocarpus angolensis*) has also been planted this way but the method cannot be considered foolproof by any means.

Root suckers.—The seed of some trees is not easy to obtain, and at least two such species, East African Camphor (*Ocotea usambarensis*) and *Millingtonia hortensis* have been planted in East Africa by means of root suckers, which can be lifted from under mature trees (felled in the case of Camphor) and lined out in a nursery.

Hardening Off

This is a most necessary operation and the severer the conditions, the more necessary it

becomes. Transplants grown with excessive watering under shade may wilt in a few minutes on exposure to bright sunlight in a dry locality. As soon as possible after transplanting, therefore it is desirable to remove the shades progressively, either by reducing their density, or by taking them off for a longer and longer period every day, until the trees are able to withstand direct sunlight. At the same time, the amount of water applied should be reduced. In transplant beds watering should be heavier but less frequent than in seedbeds. In very dry areas it is desirable for a few weeks before planting to keep the watering down even to the level where the plants show signs of incipient wilting. It will probably be found, with beds of potted plants, that the outer ones tend to wilt much more easily than those in the centre. This can be checked by constructing wooden walls around the beds, or by piling earth up against the outer pots. In mountain areas, especially where mist is frequent it is possible, and very desirable, to dispense with shade completely, except for a week or two after transplanting.

Planting Out

Culling.—It is unwise to put out poor nursery stock into a planting area, as it is unlikely to survive and increases the labour of filling up blanks. The usual custom is to raise at least 25 per cent more plants than will be required, and to reject any which are not healthy, vigorous and of the right size, at the time of planting. Some of the smaller rejects can be used for filling blanks later in the season.

Time of planting.—Ideally, plants should only be put out in a plantation during dull, humid weather, and after the ground has been well soaked by a heavy storm or a period of rain. In high rainfall areas in Tanganyika, this is usually fairly easy to arrange, as such conditions are frequent for several weeks after the onset of the "long" rains, that is in late March or April. In the drier areas there is often no ideal planting period. If planting is done at the beginning of the "long" rains, i.e. in April, the trees have frequently an inadequate period in which to establish themselves before having to face a five or six months drought. It is therefore usual to follow the agricultural practice of the region, which is to plant in the pre-Christmas rains, but where there is normally a severe break between "short" and "long" rains, it is safest to plan for "long" rains planting. Nursery stock cannot, unfortunately, be held back for four months if the "short" rains fail.

"Short" rains planting in dry localities can be a very tricky operation. Sudden storms are frequently interspersed with dry spells which restore the soil almost to its dry season state. It is easy to lose the entire stock of plants by an unfortunate combination of wet and dry spells. Fast-growing plants such as *Eucalyptus* species, cannot be held in the nursery for too long as they tend to out-grow the limited root system contained in the pot. The only advice that can be given is to harden off the seedlings to the utmost, raise more stock then necessary, cull the poor plants ruthlessly, hold back the smaller ones for later planting in blanks, and organize planting so that it can all be done in a very short period as soon as conditions appear favourable.

When trees and crops are being planted on the same area it is a great convenience to plant the trees at the same time as, or a little before the crops. In many places crops are sown in the short rains, whereas the best planting time for trees is in the long rains. In this case it is usually better to put forward the tree planting to coincide with agricultural practice as it simplifies weeding and avoids the inconvenience of having to stake and plant under high crops. It has been claimed that the shade of high crops aids establishment, but if transplants are well hardened off, they should not require shade when planted out.

Method of planting.—The main points to note are to ensure that planting causes the minimum disturbance to roots, that the "collar" of the plant is at ground level or perhaps a little lower when planted, but never higher than before, and that the soil is tamped around the roots as firmly as possible. Transplants with naked roots need especial care. They should be lifted from beds by digging out, not by pulling. Long roots should be pruned to about 6 in. length. It is often beneficial to dip the roots in liquid mud before packing them for transport. In any case the root systems should not be exposed to the air, especially to sunlight for longer than necessary. When planting, the roots must be given adequate space and not coiled up.

Potted plants are comparatively easy to plant. Banana fibre pots do not need to be removed unless termites are likely to be attracted. Baked clay pots, if tapered, can be slid off but if this is difficult, they have to be cracked. The main thing to guard against is inadequate firming of the soil around the roots.

Plantation Technique

In plantation practice, preparation of the soil is of the utmost importance, and has been discussed at the beginning of this article.

Spacing.—Trees are usually planted at a fairly close spacing, even when planted solely for timber production, where the final crop may average only 50-100 trees per acre. The object of this is, firstly, to enable the crop to form a closed canopy as soon as possible, thus reducing weed competition and fire risk, secondly, to provide a large number of trees from which to select the best to form the final crop, and thirdly, because trees growing at a close espacement tend to grow straighter and have smaller branches than those growing in isolation. The aim is to select the widest spacing which will fulfil these conditions adequately. Slow growing species of poor natural form, such as oak or beech in the United Kingdom, are frequently planted at very close espacements such as 3 ft. x 4 ft. (3,630 per acre), while species such as Teak which grow fast and straight may be planted at 10 ft. x 10 ft. (435 per acre). A few species like Mvule (*Chlorophora excelsa*) do not respond well to growing in plantations, and are often planted at wide "final crop" espacements, e.g. 30 ft. x 30 ft. (48 per acre).

In East Africa, the usual initial spacing for most species is 7 ft. x 7 ft. (889 per acre) or 8 ft. x. 8 ft. (680 per acre). At these spacings, no thinning is necessary for pole and fuel plantations, grown on short "coppice" rotations, and timber species such as *Cupressus* form a closed canopy within five years. In poor soils, or dry situations there is a tendency to use wider espacements for coniferous timber plantations.

It is usual to mark out the plantation with stakes at the required spacing a short time before planting. If done too soon the stakes are likely to be eaten by termites or stolen for firewood. In "tie-ridged" plantations staking is unnecessary, as the ridges are constructed at the desired spacing of the rows, and the "ties" can be built to mark distances between trees within the row. A convenient layout is to build ridges 4 ft. apart, with smaller "ties" 8 ft. apart, planting or sowing trees and crops on alternate ridges.

Seedlings raised by "line sowing" need to be thinned out to a normal spacing after one year. "Spot sown" seedlings should be thinned to one per spot after one year. Surplus plants obtained from this operation can sometimes be used for filling blanks. For example *Cassia siamea* thinnings are often "stumped", and used either for blank filling or for planting elsewhere.

Weeding.—It is a very common and natural feeling to suppose once the trees are actually planted, or the seed germinated, that the job is practically over. Nothing could be more misleading, and the neglect of young trees is the commonest cause of failure in plantations made by villages, schools, communal turnouts, or even by individuals. Many districts are dotted with scattered groups of a few trees each, which are the survivors of promising plantations started in a wave of enthusiasm by interested Chiefs or Government Officers. In nearly every case the main losses occur during the first season through neglect of weeding. It is difficult to understand why a community should so consistently refuse to tend a plantation which has already cost them a great deal of effort, but this is almost universal, and is noted here for the guidance of anyone concerned with the organization of village planting. It is not enough to arrange for a communal turnout, during the planting season, or an "Arbor Day" once a year. Provision must be made for sustained tending operations.

The species commonly sown in pole or fuel plantations are, in their natural state, fast-growing pioneers on destroyed forest sites. They are particularly intolerant of competition and if once smothered with grass lose vigour to such an extent that, even when subsequently freed, they take a long time to get going again. Moreover, if weeding is delayed, the weeds, especially perennial grasses, build up sufficient reserves in their rooots to sprout again with undiminished vigour. Delayed weeding is thus not merely less efficient, but also more expensive than early and frequent weeding. The best control of weeds is obtained with clean cultivation of the soil before planting, and the success of "taungya" planting is often due in some measure to the complete suppression of weed growth. As a rule plantations need from three to five weeding operations during the first season, according to the amount of rain and the initial cleanliness of the area. Fast growing species, such as *Cassia*, and Wattle, which also cast a heavy shade, should need no weeding, except in poorer patches in the second season, provided they have been clean weeded throughout the first season. Such species should not normally be grown with high native crops

unless given a month or two start, as they require plenty of light. Slower growing species need to be tended for several years, but many of them are less intolerant of competition and, once established, do not benefit from clean weeding. They must, however, be kept free from competition in their immediate vicinity.

In exposed situations young trees sometimes appear to benefit from a moderate amount of shelter afforded by crops or even weeds, provided they are not actually smothered. Where no crops are planted, it is usual to weed thoroughly in circles 3 ft. diameter around each plant and slash back tall-growing weeds in between. The weeds should never be removed from the area but may be used to form a mulch in circles around the trees but at least a foot away from them. The mulch assists in smothering weed re-growth, and helps to keep the soil surface moist. It also acts as a bait for termites and may divert their attention from the growing trees. One objection to clean weeding in termite-infested land is the fact that termites are left with nothing to eat but the trees, but even so, clean-weeding of the whole area seems to be beneficial if combined with gammexane treatment to ward off the white ants. This is particularly the case with plantations in dry grassland areas. Perennial grasses have a very marked effect on the growth of most species of trees, and are difficult to eradicate unless the area is completely cultivated to begin with, and clean weeded throughout the first season.

Blank filling.—If the plantation is less than about 85 per cent stocked, at the end of the first season, or has failed in patches, a certain amount of blank filling or "beeting" must be done. This presents no difficulty with direct sown species, but needs to be allowed for in planning nursery operations. Some "beeting" can be done throughout the first season using nursery stock that was held back at the time of planting as being too small. In the following season blanks in the older plantations should have first claim on the nursery stock, and the area of new planting reduced if necessary. Trees planted in blanks are often more difficult to establish than the original plants as they have lost the benefit of the first preliminary clearing or cultivation. They may have to compete with the older trees, and in any case are usually in the worst areas. "Beeting" should therefore be done with even greater care than the first planting. If not successful in the second or third year, especially with fast growing species, the operation may become impossible, and the plantation will remain imperfect throughout its life. It often happens however in favourable areas, that poor initial stocking is caused simply by a bad season. If the following season is normal, blanks can usually be filled easily as a routine operation.

Thinnings.—Trees are planted close together for the reasons mentioned under Spacing. The competition resulting from close spacing usually has little effect on height growth, except under very dry conditions, but a very pronounced effect on girth. Unless thinned, trees in a plantation remain thin and straggly, and of course take longer to reach merchantable size. The object of thinning is to preserve the benefits of close spacing with the minimum reduction in diameter increment.

The exact process of thinning plantations can be expressed in the form of a schedule giving the number of trees per acre at various ages throughout the life of the crop, and specifying the intensity of each thinning operation according to an accepted grade (A.B.C. or D.). The compilation of thinning schedules is based upon a great deal of research. A useful account of thinning as applied to E.A. Cypress plantations is contained in the Kenya Forest Dept. Pamphlet No. 11 "The Management of Cypress Plantations in Kenya" by S. H. Wimbush.

It is only necessary here to emphasize that thinning is an important and essential operation in the raising of timber plantations, and one that gives the forester a wide degree of control over the crop. Frequent light thinnings are preferable, from the silvicultural point of view, but short-term economic factors often make it necessary to delay the first thinning until the produce is merchantable, and later to confine thinnings to a few heavy operations, but this can rarely be done without some postponement or reduction of the final returns.

Early thinnings are normally directed towards the removal of defective trees. These include "wolves" (over-large heavy-crowned trees, which are likely to be coarsely branched), and also trees which are suppressed, forked, crooked, or diseased. Later thinnings aim at freeing "elite" trees which are to be retained to form the final crop, by removing poorer or damaged trees, having due regard to the maintenance of an even distribution of trees over the whole area.

Under-thinning reduces girth increment and thereby delays the final returns. It causes increased root competition and may lead to deterioration of the soil due to the suppression of all ground flora. In dry areas over-stocking increases the risk of drought damage.

Over-thinning tends to produce coarsely branched trees, and wastes the available space. In dry areas, however, it may be impossible to get reasonable growth rates unless the crowns are kept well away from each other. The root systems may be competing even though the crowns are not touching. For this reason, on dry sites if the aim is to get timber of merchantable size as quickly as possible it may be preferable from the economic point of view, to grow trees at a wide espacement. The total volume production per acre may be a little less, but the cost of planting is less and the timber will be of larger dimensions at a given age. Many conifers such as the Pine or Cypress species most commonly planted, retain their branches for many years even when planted close together, and have to be pruned to get knot-free timber in any case. There is thus little advantage in planting trees close together unless the site is good enough to enable them to grow rapidly even when the crowns are touching. It has therefore been suggested that wide espacements, up to 12 ft. x 12 ft. should be adopted on poor sites. In practice, however, with these wide espacements it is found that the number of trees is insufficient to give an adequate choice of good stems when thinning, and poor trees have to be accepted in the final crop. The practical limit to wide spacing is therefore about 9 ft. x 9 ft. (540 trees per acre).

In Kenya, where forest labour is abundant, the thinning schedule for Cypress prescribes eight thinning operations, reducing the number of trees per acre to 250 by the 12th year, 130 by the 21st year, and 100 by the 30th year. The crop is felled at 35 years. For comparison, the South African schedule for *Pinus patula* on the best sites prescribes only four operations, reducing the stand from 540 trees (9 ft. x 9 ft. spacing) to 300 in the 8th year, 200 in the 12th year, 130 in the 18th year, and 100 in the 25th year, the crop being felled at 30 years. On medium quality sites the trees are reduced to 300 in the 6th year, 200 in the 14th year, 100 in the 25th year, with clear felling at 40 years.

Plantations raised solely for fuel and poles and regenerated from coppice shoots on a short rotation of from 5 to 10 years only, should never be thinned, except to the normal espacement after one year in the case of trees raised by direct sowing. It is very necessary to resist the temptation to remove odd poles as and when required. The reason is that shoots from the stumps of thinnings will usually be suppressed by neighbouring trees and may be killed completely. If this happens the crop will be only partly stocked in the second rotation. It is far better to clear fell a small area. Coppice shoots in the second rotation should be reduced after one year to not more than two per stump, unless they can be used as withies when they are a little bigger.

Pruning.—Most trees have at least some tendency to prune themselves when growing in close canopy, but with the conifers commonly planted in East Africa, this process is too slow to give clean, knot-free timber within the short period they take to reach timber dimensions. As labour is also fairly cheap it is found practicable to prune all conifer plantations in Kenya where most of the softwood planting has been done. The usual pruning schedule for Cypress is given in the publication referred to above (Kenya Forest Dept. Pamphlet No. 11). This prescribes five pruning operations as follows:—

	Age.	*Mean Ht.*	*Prune to*
1.	3 years	14 feet	5 feet
2.	5 „	23 „	12 „
3.	7 „	33 „	17 „
4.	9 „	42 „	24 „
5.	12/13 „	56 „	38-44 „

In South Africa it is not considered economic to prune Pines above 22 ft. and only three pruning operations are done as follows:—

	Mean Ht.	*Prune to*
1.	20 feet	8 feet (all trees)
2.	30 „	15 „ (all trees)
3.	40 „	22 „ (150 best trees)

Early prunings should be done on all trees in the stand. Pruning causes a certain amount of check to growth, and if only the final crop trees are pruned they are liable to be set back and lose dominance.

Fire Protection.—Where afforestation is continued on a large scale for many years, a considerable amount of planning is necessary in anticipation of future problems of management, exploitation, communications, and protection. The problems of large-scale organization are beyond the scope of this article, but a few remarks are necessary on the subject of fire-protection.

Large areas of plantations, particularly of exotic conifers, should be broken up by fire-lines into units of between 100 and 200 acres. The best fire-breaks are patches of indigenous closed forest and these should be worked into the network of firelines, wherever possible. Artificial fire-lines should follow ridges and spurs thus dividing the land into natural topographic units. They should not be aligned along a contour, as it is difficult to hold a fire when it is racing uphill, but the units are automatically subdivided by roads, which follow approximate contours. Roads are an essential adjunct to the system of firebreaks, as they afford easy access and are useful base-lines from which to burn back towards a fire.

The fire-breaks themselves, should be at least 20 yards wide, with even larger ones enclosing major blocks of one or two square miles. They may be merely hoed traces but it is better to plant them up with a species that will grow faster and taller than the conifers. *Eucalyptus* species and *Acacia Melanoxylon* are ideal. By growing above the conifers they reduce the wind intensity to some extent, but the main value is in reducing the amount of grass on the fire line, thereby simplifying the task of hoeing or scuffling. It must not be supposed that a fireline is a complete answer in itself. Even when planted with trees it still has to be hoed or scuffled clean every year. Firelines must be regarded as base-lines on which to hold a fire, not as automatic barriers. A large afforestation project needs in addition, an efficient organization for spotting fires, and for mobilizing labour and equipment rapidly. Small woodlots or tribal plantations are best protected by a wide burnt area formed by cutting two peripheral paths one close to the trees, the other 30-50 yards out, and burning off in between.

If species which coppice readily such as *Cassia,* or *Eucalyptus,* are burnt accidentally, it is essential to cut the dead or scorched trees back to ground level immediately. If this is done, the trees will shoot again, but if the scorched upper part is left standing the root also will die. This should be impressed upon village communities who lose many trees every year in places like Bukoba and Sukumaland through neglecting to fell scorched trees.

Notes on Pots for Transplanting

Banana-fibre pots.—These are made from the dried, brown "migomba" which can be stripped off the bole of the banana plant, not from the green leaves. The fibre is obtained in strips 4 in. to 5 in. wide, and these are wrapped over the top of a short pole stuck in the ground, and bound with a thin strip of fibre, which is tied round it, at a distance of about 6 in. below the top of the pole. The ends of the broad fibre are then folded back and bound again by two thin strips top and bottom. The straggly ends are trimmed off, and the pot lifted off the pole. The usual size of pot is about 6 in. long x 4 in. diameter. Where "migomba" is plentiful a man can make a hundred or more pots in a day with ease. Banana fibre pots are convenient to use, but will only just last the few months they are required. They are very liable to be destroyed by termites which are attracted to them, and in some nurseries it has been found necessary to raise the pots off the ground on a staging of withies to avoid the termites.

Baked-clay pots.—These so-called pots are actually short tapered tubes open both ends, made by wrapping clay around a form, allowing to dry, and finally baking over a fire. The method is as follows:—

A wooden form is turned on a lathe, to the shape of typical flower-pot, about five inches long, and four inches diameter at the top tapering to three inches diameter at the bottom. Next, a board is obtained, about 18 inches long, 12 inches wide and rather less than half an inch thick. On this is marked out a shape, which corresponds to the surface of the tapered form assuming the surface was unrolled. The shape, which is a broad arc six inches wide, can in fact be inscribed on the board by rolling the tapered form along it for one revolution and marking the area covered in the process. Actually the arc needs to be about three-quarters of an inch longer than the true circumference of the form. This shape is then cut out, and the resulting frame is laid on a piece of smooth canvas which in turn is spread upon a flat baseboard. The frame is then ready to serve as a mould for the clay. The ideal clay for the purpose is the kind used by Africans for pot-making, but it is not necessary to go the length of preparing it as they do by pounding and sieving. If this clay is not available, it is possible to use a half-and-half mixture of light soil and clay, but it is not easy to find a mixture which can be made wet enough to mould easily without becoming sticky, and which will bake without cracking or crumbling. Experiment with different mixtures is advisable. The better the quality of the clay, the thinner the pots can be made. In Southern Rhodesia a mixture consisting of two parts ant-hill to one part sand is recommended.

In moulding the pots, the clay is pressed into the wooden frame and smoothed off level. The frame is then lifted off leaving a slab of clay of the correct shape lying on the canvas. The tapered form is then placed on the clay which is rolled up around it by means of the canvas. The two ends of the clay are then pressed together with the fingers to make a good seam, and the wooden form carefully lifted out The form should have a handle attached to its broad end for this purpose. The soft clay tube thus formed is then allowed to dry under shade for two or three days, or until it is hard enough to handle with ease. Finally the pots have to be fired. A proper kiln can be constructed for this purpose, out of roughly made bricks with iron bars to support the pots, but it is also possible to burn the pots satisfactorily by laying them in batches of a few hundred on a layer of small fuel, covering with more fuel and burning off in the open. Burning on an open fire is, however, rather wasteful of fuel, and the fuel needs to be chopped fairly small. A simple kiln can be contrived by digging a trench

in line with the prevailing wind, and laying iron bars across it. A fire is maintained in the trench, and the pots laid on their sides on the iron grid.

It s not necessary to burn the pots very thoroughly, but they should have baked to a red colour at least in patches.

Clay pots should not cost more than two or three cents each, and usually cost less, once the technique has been mastered. A man can mould at least 100 per day (250 per day claimed in Southern Rhodesia). The cost of burning will depend to a large extent on the supply of fuel, but if plenty is available a gang of five men should be able to mould 500 pots one day, and the next day cut fuel and burn off the 500 pots made three days previously, thus averaging 50 per man-day. There are, however, likely to be substantial losses from breakage, particularly if the work is done with poor labour, using inferior clay, and burning on open fires.

At the time of planting, the plant is carefully removed from the pot by tapping out the core of earth and roots in one piece. After planting the pot can be inverted over the plant to provide partial shade and protection or returned to the nursery to be used again.

It has been found possible to simplify the above technique to some extent by using a glass bottle in place of a tapered wooden core. The shape cut out of the frame is then a simple rectangle. The bottle is moistened before rolling the clay around it and will then slide out easily despite its lack of taper. It is not possible, however, to remove the pot whole at the time of planting and it must therefore be cracked or broken off.

In Palestine planting is sometimes done with beautifully made clay pots, which are spun very rapidly by skilled potters on a potters wheel. This technique has, however, not yet reached Tanganyika.

Grass pots.—It is possible to make inferior pots by wrapping or plaiting grass or other material around a form, but these pots are usually not very satisfactory and are more difficult to make than banana fibre pots.

Palm frond baskets.—Natives on the coast are accustomed to weaving baskets of various sizes from the fronds of palm trees. They are used for handling small quantities of produce in the fruit-markets. Small pots of this type have been used for raising ornamental trees in Dar es Salaam.

Proprietary pots.—In most countries it is possible to buy proprietary "flower pots" made of earthenware, plastic, metal, or various other substances, and these are usually very suitable for three seedlings but, of course, far too expensive for anything other than small-scale ornamental or research work. It is not easy to devise any sort of pot which could be manufactured in quantity for a price as low as one or two cents each, and which will stand watering, etc., for several months in a nursery. Many materials have been suggested including compressed earth, greased paper of the sort used for ice cream cartons, tinplate, roofing felt, wood veneer, etc. etc.

"Tar paper" tubes.—These are being used in at least one nursery in California. The basic material is "roofing paper" of the kind known as "30 lbs. weight". This is cut into a special shape about 12 in. square rolled into cylinders or better folded to form square-section tubes roughly 3 in. x 3 in. x 12 in. which can be pressed flat for storage. The edges are sealed with hot tar. They cost about 2½ U.S. cents each in California (about cents 20 E.A. currency), of which half is the cost of materials, and half the cost of labour. A gang of four men make 2,000 a day.

"Veneer tubes" made of *P. radiata* veneer 1/40 in. thick, are being used in Australia. They are made from pieces of veneer 6 in. x 12 in., wrapped round a cylinder 1½ in. diameter to give a 6 in. tube with walls two or three layers thick. They are held together with rubber bands.

Metal tubes made of tinplate, 8 in. long by 2 in. diameter, are used in Hong Kong.

Bamboo tubes.—In many parts of the world, including a few places in East Africa, it is possible to obtain large diameter bamboos, which make excellent pots. The bamboo is sawn into 8 in. sections, and each section split vertically. The two halves are then bound together again with wire. The object of splitting them is to facilitate removal of the "pot" when planting. The pot can be used again.

References

For more detailed information in regard to tree-planting and the characteristics of species suited to Tanganyika conditions, the reader is referred to the following publications, many of which could probably be seen in most Forest Offices.

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THE SIXTH BRITISH COMMONWEALTH CONFERENCE, CANADA, 1952

By A. L. Griffith, East African Agriculture and Forestry Research Organization

These conferences are held every five years, and each time in a different part of the Empire. The series started in 1919 and so far have been held in the United Kingdom (twice), Canada (twice), Australia and New Zealand, and South Africa. The fifth conference was due to take place in India in 1940, but had to be abandoned owing to the war, and the next conference (the seventh) will be in Australia and New Zealand in 1957.

The great value of the conferences is not only in the important official "business" that is done, but in the gathering of Forest Officers from all over the Empire, so that they can meet their opposite numbers and discuss their mutual problems. This last conference was held in Canada in September and October of last year, and East Africa was represented by the three Chief Conservators of Forests (Messrs. Waterer, Kenya; Swabey, Uganda, and Dr. Eggeling, Tanganyika), the Silviculturist of E.A.A.F.R.O. (Dr. Griffith), and by Mr. Hoddinott who represented the E.A. Timber Co-operative Society Ltd.

Altogether, there were about 120 delegates and observers from 22 different parts of the Commonwealth. These included 24 members of the timber trade and allied industries, and observers from the U.S.A. and F.A.O. General Forest Research and Forest Products Research were also well represented.

The Conference met in Ottawa on August 11th, and after three days, which were mainly spent in reviewing what action had been taken on the resolutions of the fifth conference, the party left for a fortnight's tour through the provinces of Quebec and Ontario. This was followed by two weeks of solid conference in Ottawa after which the majority of delegates left for a tour of about two weeks in British Columbia and Vancouver Island.

This conference was of great interest to East Africa for Canada is a big, new and sparsely populated country (a population less than that of Switzerland—one of the world's smallest countries!). It is essentially a forest country, and in the past there has been great waste of their forest resources. Now they are really getting down to forest management on a sustained yield basis. It is a country of softwoods that are being developed, though of course not as we are forced to do by plantations, it is a natural softwood forest. It is a country of few and poor communications and these are often out of action, hence East Africa has a lot to learn from them of the way they are tackling their forest problems.

It was a most interesting and instructive conference, but was marred by the death in Ottawa of Lord Robinson, the leader of the Forestry Commission delegation, and who may be said to be the father of U.K. forestry. He had attended these conference since the first, in 1919.

Apart from "straight official shop" a great deal of interest was learned that has direct application to East African forestry, farming, and our general way of life. I was much impressed by the way the Canadians have put over forestry to the people. The Forest Department all wear uniform, and everyone knows what a forest officer is, and what he does. Every forest is labelled by notice boards, and youth education on the value of forests to the country is very well carried out. They get over their poor communications by highly developed air and radio connexions. Each Provincial Forest Department has its own Air Service and Radio Service as sections of the department. They build their own radios. A typical example of how everyone joins in, high and low, is that in Ontario the Minister for Forests pilots one of the Forest Department planes.

It is impossible to list all that we saw of application to these territories, but I detail a few of the subjects that impressed me.

Air dropping for supplying forest parties in difficult areas with food supplies, information, etc., has been well developed in some provinces. Fire-fighting equipment and technique has reached a high degree of efficiency (and so it should for Canada each year destroys by fire about half as much of its forest resources as it utilizes!). Australia is utilizing gums (*Eucalyptus* spp.) for paper as well as mangroves from New Guinea. At the Dominion Experiment Station at Petawawa we saw a simple instrument for the measurement of dew precipitation, a thing we know little or nothing about here in East Africa, and it is probably one of our

most important forms of precipitation. Radio active elements are used to follow the movement of nutrients and diseases in trees.

Chemical sprays of both herbicides and arboricides (for killing soft and also woody species) are used with great success in keeping road sides, electric power lines, fire lines, water lines, etc., clear of vegetation. We saw new methods of air photography, mapping and of making "inventories" (the U.S.A. and Canadian name for forest enumerations!).

Another point of interest is that like the U.S.A. and India, the control of National Parks and of Game Parks is by the Forest Department, and not by separate departments. This gives a much more realistic view and control of natural resources by one authority, and does not lead to conflicting policies by the same government.

We also saw the Canadian National Exhibition in Toronto, and at this there was a really live exhibit by the Forest Department. This is seen by about 300,000 people a day for two weeks, which is quite an appreciable proportion of the Canadian population. It is followed up by propaganda in eating houses and restaurants where the napkins, etc., have slogans and pictures about forest fires, etc. We here have made a small start at our Royal Show, but it is a lesson we might well copy.

The occasion of the conference was also used to hold two meetings of the Empire Forestry Association, one in Ottawa, and the other in Vancouver. I think that up to this no meetings of the E.F.A. had been held outside the U.K., hence it was a truly memorable conference. During the conference loyal messages were sent to H.M. The Queen by both the Conference as a whole and by the Empire Forestry Association. These were both unique occurrences in the history of Empire Forestry.

We greatly look forward to the Seventh Conference to be held in 1957 in Australia and New Zealand, for East Africa has a lot to learn from S.E. Asia about the gums, wattles and exotic softwoods on which we are so dependent for our day to day economics.

REVIEW

TREES AND SHRUBS OF THE KRUGER NATIONAL PARK, by L. E. Codd, D.Sc., Department of Agriculture; Botanical Survey Memoir No. 26 Government Printer, Pretoria, 1951, 192 pages. 7/6d.

National Parks, at least those in Africa are usually considered to be primarily pieces of land set aside for preservation of animals. It is to see these animals that the majority of visitors go. Many of the visitors are, however, undoubtedly interested in the plants which they see growing in the parks and it is for these people that this book has been written. There are similar accounts of Belgian Congo parks and it is to be hoped that further books of this nature will appear in East Africa.

Dr. Codd's booklet is written in non-technical but accurate language and should enable any visitor to the Kruger National Park to put a name to most of the shrubs he is likely to find and will also be of use (if due caution is exercised) in areas outside the park. The illustrations are profuse and magnificent—there is hardly a page without a line drawing or photograph and many have two. The six coloured plates deserve special praise and are almost of the same standard as Curtis Botanical Magazine.

There is a brief introductory ecological account of the vegetation of the park accompanied by some excellent animal photographs. Two pages are devoted to exotic species and the rest of the booklet to the indigenous ones of which 258 are described. The nomenclature is unusually up to date and there are few mistakes of any kind. There are indices to scientific and popular (both native and English) names. A companion volume on the Herbaceous plants would be welcome.

B.V.

CORRIGENDUM

THE EFFECT OF TRYPANOSOMA RHODESIENSE ON TEMPERATURES OF SHEEP, by E. Burtt.

In the July, 1952, issue (Volume 18, No. 1) of this Journal, page 121, Summary, line 2, the mean temperature of healthy sheep was printed as 102.8° F. This should read 102.08° F. in accordance with Table I column 2 on page 36 of the same article.

FOREST NURSERY COURSE, MUGUGA, 1952

At the end of 1952 a Nursery Course for Foresters and Forest Officers was held at Muguga under the auspices of the E.A.A.F.R.O. Extensive touring in the territories by specialists had shown that in the many forest nurseries, varying results were being obtained by similar methods and similar results by varying methods. The Forest Technical Co-ordinating Committee therefore asked E.A.A.F.R.O. to run a course of instruction and discussion on the basic principles of nursery work so that future lines of nursery research could be clarified.

This course was held in November, 1952, for a week. It consisted of theoretical discussions and practical demonstrations in Muguga forest research nursery and arboretum. Although, of course, arrangements were upset by the Emergency, it was nevertheless attended by 17 foresters and forest officers representing the three mainland territories and also Zanzibar. Talks were given by various E.A.A.F.R.O. specialists, and other outside officers. Visits were made to some Kenya softwood nurseries and plantations, and the following week a three-day visit to Nyeri and its vicinity was attended by delegates from Uganda and Tanganyika.

It was the first course of its kind to be held in Muguga, and as such was largely exploratory. One of the great advantages of a meeting of this kind is that foresters, who largely lead a solitary life in the back of beyond, can get together and know each other, and discuss their problems which are often very similar. It tends to break down one of the curses of East Africa —parochialism.

The course was voted a great success, and was felt to supply a need of the territories, although, of course, not strictly research, which is E.A.A.F.R.O.'s main function. A recent meeting of the Forest Technical Co-ordinating Committee has asked for a second course to be held this year (1953). We hope to hold it about mid November. On our experience of last year, the next course is to be for about 10 days' duration instead of a week in order that more time can be spent in discussion and so that delegates will be able to consult E.A.A.F.R.O. specialists and discuss special subjects. The course will be limited to 20 delegates, as it is felt that more than this number would be unwieldy, and would mean that the best advantage would not be obtained from the visit. It is hoped that a few local farmers or others interested will be able to attend at least for part of the time—farm forestry is an integral part of East African economy, and this means nurseries. Good nursery work means cheaper and better farm plantations.

Running such a course is hard work for the staff in the preliminary arrangements, the course itself and the aftermath, but we do feel that it supplies a need of the territories and is therefore well worth while. It is a great help also to the E.A.A.F.R.O. specialists themselves, for the general discussions indicate what are the priority needs of our research work. We unfortunately have not the staff or the funds to do all we should like to do, and such a gathering as this with its very frank discussions do give us a guide to what is wanted from us.

From the E.A.A.F.R.O. point of view, it was good to see the gathering of the forest clans, and to hear their discussions and criticisms. The course was very concentrated, and one delegate even expressed the opinion that he had been "overstimulated" but no doubt by now, in the back of beyond again, he has got over this phase!

The moral of the course was that "good nursery work means bigger, better, cheaper and quicker plants". This object can only be achieved if the basic principles of the job are understood and applied to local conditions. We hope we have been able to do something to help.

A. L. GRIFFITH.

ORCHIDS

At the beginning of January this year there appeared in the Nairobi bookshops a small dark green cloth-bound book in a pink paper jacket entitled "A Book of East African Orchids", by Frank Piers, M.D., its price being Sh. 15. It is about 6 in. × 8 in. in size and contains 112 pages.

It is entirely an East African production, being written in East Africa, published by the Patwa Publications and printed by the East Africa Printing Press, Ltd., both of Nairobi. The book has as a frontispiece, a full-page photograph of *Angraecum giryamae* in its natural habitat on a tidal creek on the Kenya Coast. It is followed by a foreword by Major H. B. Sharpe, an introduction, a contents page and a list of illustrations. The next nine pages contain a description of the orchid plant and its flower, and a bibliography. The rest of the book is divided into Part I: Angraecoids (Epiphytic Orchids), Part II: Non-Angraecoid Epiphytics, Part III: Terrestrial Orchids, and finishes with a final section "By the Way" and Index.

There are 60 figures, a few of which are quite good but judging from the bulk one is forced to the conclusion that printers in East Africa other than government have yet to learn the art of block-making for the good reproduction of photographs. Two photographs on one plate (figures 44 and 45) have been mixed, a *Vanilla* is labelled *Polystachya* and a *Polystachya, Vanilla,* and figure 50 is upside-down.

Five pages are devoted to the orchid plant and its flower in which these are described in some detail. Two figures are given over to the structure of two kinds of orchid plants and two kinds of flower.

The bibliography is short, and amongst the few books and papers quoted reference is made to an unpublished ms. "A Key to East African orchids" (but where it can be consulted is not stated) also to the amateur pioneers of East African orchid literature, W. M. and R. E. Moreau's "A short introduction to the epiphytic orchids of East Africa" in the *Journal of the East African Natural History Society,* Vol. 17, pp. 1-32 (1943).

In Part I of the main portion of the book Angraecoids (Epiphytic Orchids)—the genera are arranged alphabetically—eleven genera of this group along with their species both named and unnamed are described in non-technical language and their distribution given.

Part II consists of Non-Angraecoid Epiphytics and is similarly arranged but has only six genera, the largest of these being the genus *Polystachya* of which the Moreaus recorded 74 species for East Africa. In this section the author only deals with six named and two unnamed species which he considers the more interesting and these from the Kenya Highlands only.

In Part III—Terrestrial Orchids—the author deals with some species in the genera *Bonatea, Calanthe, Disa, Euloiphia* including *Lissochilus, Eulophidium, Habenaria, Platycoryne* and *Satyrium* of the more common terrestrial genera found in East Africa.

In all these parts each genus is represented by one or two figures which should help anyone who is interested, but does not know much about orchids, to identify, as far as the genus, an orchid when he finds one.

The chapter "By the Way" is discursive where the author points out that he has made an attempt to give the reader a general impression of the variety of the East African orchid flora and quite rightly says the chapter on terrestrial orchids is rather incomplete. He says too that East African orchids remain in regrettable and undeserved obscurity, as there are quite a number which would add interest and beauty to any orchid grower's collection, and he is of the opinion that their cultivation and hybridization should be taken up by growers.

The author is indebted to Messrs. E. W. Carroll and G. R. Cunningham van Someren for 12 of the photographs of the 60 figures published, many of which as I have said before, do not do full justice to the photographs. The printing also is dirty in spite of glossy paper being used. The book would have been of more value had there been keys to the genera and species but this is a defect the author will no doubt rectify should another edition be called for.

To those of us in East Africa interested in the plants around us and in particular in orchids, whether growing in trees or on the ground, Frank Piers's "Book of East African Orchids" will be a very welcome addition to the few popular books already published on the East African flora. We are indebted to a very busy medical man for his industry and enthusiasm in quite another field which he has taken up as a hobby.

P.J.G.

REVIEWS

Sand and Water Culture Methods Used in the Study of Plant Nutrition

By E. J. Hewitt. Tech. Comm. 22, Comm. Bur. Hort. Plant. Crops. East Malling, Kent. 241 pages, 29 figures, 9 plates, 23 tables and a very extensive bibliography. Price Sh. 42.

The scientific literature of the world is growing at such a rate that only the best-equipped libraries can keep pace with it. Even if these are readily available, each scientific worker, like a sheep, must browse on many leaves before he extracts the nourishment required. He must digest the gross bulk of the material connected with his subject before he can consider something new and in the process he, too, eliminates a great amount of non-essentials. Bulk may be necessary for the process of elimination in animals but it is not necessary in the nutrition of the mind. Efficient summaries are, therefore, some of the most important items in the armoury of the modern research worker. When these summaries are made by an expert in a particular field their value is greatly increased.

For many years now the Commonwealth Bureaux, whether of Horticulture, Soils, or others, have been producing a very valuable series of Technical Communications by selected authors. These are, in the main, summaries of particular aspects of present-day scientific knowledge. Their value is well known and they form an important section in any reference library worthy of the name. This well-produced and well-written book on the practical details associated with the growth and nutrition of plants under controlled conditions in sand and water culture is the latest to reach us from the Commonwealth Bureau of Horticulture and Plantation Crops.

The author needs no introduction, for he is one of the well-known team of Long Ashton workers who have spent many years investigating the nutrition of many types of plants. He has now summarized the practical methods of doing nutrition experiments. In doing so he has drawn on not only his own experience at Long Ashton but on the work of others. This has involved a survey of some 900 papers and many private communications, all of which are listed in the 31-page Bibliography, which in itself is invaluable. He has divided his book into two parts; one is a General Review, the other is a detailed account of the Long Ashton technique for large-scale sand cultures. Between them he has provided the answers to most of the questions which crop up when starting experiments of this kind.

The questions most often asked are: what size of container; what quality of water and nutrients; what amount of solutions and how often should they be renewed and so on. This book does not of course pretend to answer them in detail, for the correct choice will depend on the material to be investigated and the precision required. Nevertheless a careful perusal of its pages will soon show which are likely to be the most suitable techniques. In this manner much preliminary investigation can be saved. Consider, for example, the subject of containers. The author devotes some 20 pages to these alone and discusses, among other things, their capacity, shape, composition and cleaning. Another 20 pages are devoted to the sources, impurities and purification of water. The chapters on the impurities and purification of nutrient salts are essential reading for those concerned with minor element deficiencies. When in addition to these, many chapters are devoted to the quality of sand, its particle size and purification, methods of application and renewal of solution, methods of producing controlled environment, tree culture in sand and so on, it can be realized that this book covers in a most thorough manner the practical details required by the experimenter.

This book should be in the possession of every Plant Physiologist and every Chemist and Agronomist who studies plant nutrition. It will remain an invaluable reference book for many years to come.

The Commonwealth Bureau of Horticulture and Plantation Crops is to be congratulated on the production of this and Technical Publication No. 17* which together summarize much of the work in the field of plant nutrition.

J.G.

* Chemical composition of plants as an index of their nutritional status. D. W. Goodall and F. G. Gregory. Tech. Pub. 17 (1947), Price Sh. 9.

MATERIÆ VEGETABILES: A new journal published by Dr. W. Junk, 13 Van Stolkweg, The Hague, Netherlands.

Last July a new journal was published and in its Introduction it states "The botanical review *Materiæ Vegetabiles* will be dedicated to the whole domain of vegetable raw materials. It will be a connecting link on the one hand between research, cultivation and extraction, amelioration, preparation and utilization on the other".

It is sponsored by The International Commission for Plant Raw Materials, a body of experts set up at a general meeting of the International Botanical Congress in Stockholm in 1950 and through the kindness of the Director of the Geobotanical Institute Rubel in Zürich the Commission has been temporarily housed by that Institute.

The review is to appear in four numbers to a volume, which will cost 40-Dutch guilders, and is under the joint editorship of Prof. Dr. C. Regel, Zürich-Baghdad, and Prof. Dr. F. Tobler, Schopfacker, Trogen, Switzerland.

The present number contains 128 pages and to quote the Introduction again: "The articles will be published in several languages with preference in the following: English, French, German, Italian and Spanish, with a summary in a second language to facilitate understanding of the original".

In this first number the following articles have been published: "Karroid and Karoo Veld as Nutrition to Farm Animals", in English, by Marquerite Henrici, pp. 5-16 with a resumé in French. "Der Lein als Oel-und Faserpflanze des La Plata-Gebiets", in German by Alber Boerger, pp. 17-42 with a resumé in French. "Die Wissenchaftlichen Grundlagen der Harznutzung und Ihre Praktischen Auswerkungen", in German by Karl Mazek-Fialla, pp. 43-59 with nine tables, six text figures and a summary in English. "The Cæsalpinias as Tanning Materials", in English by F. N. Howes, pp. 60-74 with a resumé in French. "Uber den Einfluss der Düngung auf die Faserentwicklung der Yucca-Pflanze", in German by von A. Th. Czaja, pp. 75-106, 10 tables and text figures but no summary. "The Significance of Terpene Accumulation in Plants", in English by J. P. Riches, pp. 107-112 with a summary in English. "Die Verwertung der Fasern von Stämmen der Essbaren Bananen", in German by Friedeech Tobler, pp. 113-118 with a resumé in French and "Le Styrax en Grece", in French by Ch. Diapoulis, pp.119-121 with a text map and summary in English.

Page 122 is taken up with an account of how the International Commission for Plant Raw Materials came into being with the names of the members of the Commission. The remaining pages are devoted to reviews of books and papers dealing in a wide sense with plant products.

To those dealing with economic plants, their cultivation products and preparation to the finished product this publication should be of value in keeping them abreast of present day trends.

As a taxonomic botanist with an interest in economic plants the reviewer considers that, in view of the international status of the Commission, the editors should be more exacting of authors in their articles, in that they should quote the botanical name or names with authorities of the plants mentioned: for example, the long paper on Flax as an oil and a fibre plant does not once mention *Linum usitatissimum L.*

Again, it should not be necessary to consult a dictionary of economic plants and their products to find what genera and species of Coniferae yielded the resin dealt with in the article "The Fundamental Scientific Doctrine on the Utilization of Resins and its Practical Results".

The very interesting paper on the effects of fertilizers on the fibre growth in *Yucca* plants fails to state from the start what species of *Yucca* was used in the experiments and it is not until one has read to p. 95 from p. 75 does one learn that *Y. filamentosa L.* was used. A summary or a translation in English of this paper would be of very great interest to the growers of Sisal, *Agave sisalana* Perrine in East Africa.

The article on the usefulness of fibres from the stems of edible bananas does quote the botanical names of the various species mentioned. unfortunately they are now out of date, according to the researches by Prof. E. A. Cheesman of the Imperial College of Tropical Agriculture, Trinidad, on this difficult but widely distributed group of plants in the tropics. The results of his taxonomic work on this genus are now appearing in the *Kew Bulletin.*

I think, then, considering the international composition of the Commission, and the intention that this new journal should be read internationally, that the editors should insist that authors should at least give the Latin names of the plants from which plant raw materials are obtained and about which they are writing.

P. J. GREENWAY.

MANAGEMENT AND CONSERVATION OF VEGETATION IN AFRICA. A Symposium (1951). Bulletin No. 41 of the Commonwealth Bureau of Pastures and Field Crops, Penglais, Aberystwyth, Wales. pp. 1-97, plates 38, maps 6. Sh. 10/50.

This valuable publication consists of seven articles by officers of the various concerned technical departments of South Africa, East Africa, Tanganyika Territory, Sierra Leone, Nigeria, the Sudan and the Gold Coast. It emphasizes that if periodic food shortages are to be avoided, soil conservation through the proper management of the vegetation cover is a major necessity.

It does not go into details of land management, but is written from the angle of vegetation surveys, and the mapping and description of the broad types of vegetation that exist and describes what is happening to them. In general, the conclusions reached are that with the increase of population and particularly with the settling of a normally nomadic native population, shifting cultivation, the misuse of fire and unmanaged grazing and overstocking, are becoming progressively rapidly more serious. All the countries stress the need for detailed surveys of the various soil, climatic and vegetation conditions, and in general consider that these should first be carried out in areas where farming is marginal. South Africa is one of the few countries where such detailed surveys have largely been done.

The South African contribution (J. D. Scott, Professor of Pasture Management, University of Natal, Pietermaritzberg) is a comprehensive review for a very large field, and in addition gives an interesting and concise history of how soil conservation and deterioration started and has progressed in the Union. The note of D. C. Edwards (Senior Pasture Research Officer, Nairobi, Kenya) gives an interesting account of the vegetational types of Kenya with the causes of deterioration, and an assessment of the problem of rehabilitating the vast areas that have degraded. It is a pity, however, that he makes no mention of the wholesale destruction of Kenya's forests that has occurred in comparatively recent years. The article on Tanganyika (H. J. van Rensburg, Pasture Research Officer, Mpwapwa) after describing the vegetation types of his territory, suggests that a number of development plans are based on the idea that improvement has to continue on lines which the African can follow. He concludes that this means that progress will necessarily be slow, and suggests that this is not good enough and that the change from a system of primitive exploitive farming to sound farming whereby local reources can be utilized to the best advantage must be speeded up by modern methods.

The notes on the other parts of Africa (Sierra Leone, Nigeria, the Sudan and the Gold Coast) are of course not of such interest to residents in East Africa, but are well worth reading as showing that the same destructive processes are at work, e.g. Nigeria and the Gold Coast, though they are at present in a much earlier stage.

The situation is well summed up by J. H. Hinds (Agricultural Officer, Gold Coast) who writes "Man as a biotic factor has assumed greatly enhanced importance in comparatively recent years. How and at what level he will again come to terms with the soil and vegetation of his environment is a matter of speculation. It is obvious that methods must be devised to enable man to live not, as it were, parasitically on the land and vegetation, taking all and giving nothing, but that he should live in symbiosis with them, conserving and replenishing all that is good and useful. If this cannot be achieved there must inevitably be a gradual but progressive deterioration of the soil and vegetation assets of the country".

The book is well produced in clear print and is illustrated by 38 excellent photographs and six maps. It is to be recommended to all those who have the productivity of East Africa at heart.

A.L.G.

THE DWARF GOATS OF AFRICA

By H. Epstein, P.O. Box 7011, Jerusalem, Israel

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Distribution and Characteristics of the Dwarf Goats of Africa

In the kitchen middens of the prehistoric inhabitants of Toukh, on the left bank of the Nile, south-east of Abydos, de Morgan (1897) found the bones of a dwarf goat, closely allied to the recent diminutive breed of the country between the White Nile and the Niger. Standing not more than 20 inches at the shoulder, this goat has horns in both sexes, although these do not exceed four or five inches in length. A horn length of 12.5 inches, as recorded in an aged male African dwarf goat in the zoological garden at Halle, is exceptional.

Schweinfurth (1912) records the rock drawing of a goat from Assuan, dated to the Old or the Middle Kingdom of Egypt. Characterized by scimitar-shaped horns, erect ears, a convex facial profile, and the absence of a beard, it is considered identical with the Ethiopian dwarf goat bred by the majority of the Hamitic Beja people of the Egyptian desert and Sudan, and known from ancient Egypt in a mummified state (Lortet and Gaillard, 1905). Pictorial records of this goat are few and far between. It seems to be represented on a slate palette from the latest predynastic period and on the ivory knife handle from Gebel el 'Araq, dating from the time of the invasion of the dynastic people into Egypt. It also occurs on a carved mace head of Nar-mer, first king of the First Dynasty, depicting a triumph or census, when 400,000 oxen, 1,422,000 goats and 120,000 men were taken (Petrie, 1939).

At the present time the distributional area of the dwarf goats of Africa extends from the coastal region of the Red Sea and Somaliland through Central to West Africa. In northern Africa the dwarf goat is found in the Anti Atlas and Sus, Morocco, where flocks of small, plump specimens may be observed, browsing or resting in the wind-shaken branches of trees up to ten metres above the ground (Marçus, 1933).

The African dwarf goat was known to Linnaeus as *Capra reversa*. Fitzinger described it with the name of *Hircus reversus*. Chang and Landauer (1950) assume that its original home was in Guinea and neighbouring regions of the African west coast, from where it spread through Central Africa as far as the east coast of the continent. This suggestion, however, is not supported by the available evidence which indicates that the dwarf goat reached West Africa from the east and north-east. "As regards domestic animals", Johnston (1906) writes, "the dog was the earliest in Negroland, and then after a very long interval—an interval during which Liberia's Miocene forests may still have been unpenetrated by man—came the goat from Egypt. I think it will be found that the goat of the Central African type was the first domesticated animal of the black man, after the dog; if, indeed, the dog preceded it."

The Nilotic dwarf goat is only about half the size of the ordinary savanna goat. It shows great variety of colouring, including all proportions of white, black, and bright tan. The coat is very short, the beard and mane are rudimentary, and the ears short. Both sexes usually carry horns, but even in the male these are very small, and in the female they may be absent. The typical horn is only two or three inches long, erect, and with the point turned slightly forwards. The females yield only a few ounces of milk daily (Bennett, John and Hewison, 1948).

Schweinfurth (1918) describes the goats of the Bisharin, one of the Eastern Hamitic Beja people inhabiting the Egyptian desert, but extending some 80 miles south of the Egyptian Sudan boundary and occupying a strip of territory on the Atbara River, as very small and quite different from the goats of the Nile valley. At Marsa Halaib, in the coastal region of the Red Sea, he found a dwarf breed of goats, brown or variegated in colour (Schweinfurth, 1926).

The dwarf goats of Somaliland are diminutive animals of very slender build, characterized by the short glossy coat and the absence of a mane. The usual colour is white, occasionally with a black dorsal stripe, one or two black facial lines, and black ears; a black-and-tan-and-white variety is not uncommon. The facial profile is straight, the ears are erect and of moderate length, and the horns of the male short and twisted, while the female is commonly polled. In colour and conformation the Somali goat shows a remarkable resemblance to the Buduma goat of Lake Chad, which is also almost entirely white (Herzog zu Mecklenburg, 1912). The dwarf goats of the Arusi Galla of

southern Abyssinia, beyond the western range of the Somali goats, are distinguished by long fleecy coats (Drake-Brockman, 1912).

Dwarf Goat from Lendu and Ussoga. After Mueller.

The dwarf goat of East Africa reaches a shoulder height of 50 cm., a body length of 70 cm., and a weight of 25 kilogrammes. The body is compact, and the legs are short and sturdy. Both sexes are horned, but the horns are usually very short, rarely exceeding finger length. The ears are erect, as in all other African dwarf goats. Some carry a long, others a short dense coat which commonly consists of a mixture of black and reddish hair. Completely red, brown or black dwarf goats are rare, while white spots on a dark ground are a frequent pattern (Mueller, 1903).

Short-legged Bongo Goat. After Schweinfurth.

The Bongo, a true Negro people of the Eastern Sudan, and the Mittu, of the high Nilotic group of inter-Congo-Nile tribes, possess two different breeds, one of which is dwarfish and characterized by the heavy body and short legs. These goats are furnished with a long beard and long hair on the neck, shoulders, back and upper parts of the hind legs. The prevailing colour is black-and-white (Schweinfurth, 1918).

In the dwarf goats of the Sudan the horns do not exceed 3 or 4 in. in length, curving backwards and outwards, with their tips bending forwards. The legs are short and stout. The short thick hair is generally dark-coloured, frequently showing a mixture of black and reddish. Sometimes the general dark colour is relieved by white spots; but red, yellowish brown and completely black specimens are not uncommon. From the chin a black beard reaches down to the chest where it divides, spreading over the shoulders and upper parts of the fore-limbs (Lydekker, 1893-96). The typical conformation is characterized by the relatively deep heavy body, short sturdy legs, and short head with highly developed neurocranium. However, not all Sudanese dwarf goats comply with this description; some differ considerably from the typical form, approaching the general conformation of slender goats of ordinary size.

Dwarf Goat from the Sudan. After Klatt.

In Busoga and Eastern Uganda a breed of domestic goat is often met with that is prized for its unusual appearance. The hair grows extremely long over the back and sides, and on the top of the head. It falls over the eyes like the hair of a Skye terrier. This seems to be a breed that came from the Nile regions, and it is one which reappears again to the west near the north end of Lake Albert (Johnston, 1902).

In the eastern part of the Belgian Congo three basic types of goat are commonly distinguished: (1) a dwarf goat with a short coat of hair; (2) a dwarf variety with a long fleece; and (3) the savanna goat of ordinary size, either short-coated or furnished with a long pelage (Leplae, 1937). In addition to these three basic types, an offshoot of the Nubian goat, considerably reduced in body size, has

reached the north-eastern corner of the Belgian Congo from the Anglo-Egyptian Sudan.

The short-coated dwarf goat of eastern Congoland is found at the upper Uele and upper Ituri Rivers, in the vicinity of Lake Kivu, in Urundi, and the country north and west of Lake Tanganyika. This type is generally characterized by the black-and-white colour pattern, less frequently by a brown or black coloured coat, the short head with prominent forehead, occasionally polled or furnished with scimitar-like or twisted horns 5 to 10 cm. long, small eyes and short erect ears, the absence of a beard, the occasional presence of throat lappets, and the plump compact and well covered body standing on short straight or crooked legs. The tail is of medium length and carried either horizontally or upright. These goats stand 45 to 50 cm. at the withers; but in savanna country they may reach a height of 60 or 70 cm., their size, in general, being dependent on environment rather than on race. The milking qualities of the short-coated dwarf type are negligible.

The long-haired variety extends over approximately the same distributional area; but while in some parts of the range the short-coated type prevails, in others the long-haired variety is more frequently encountered. The latter is furnished with a long fleece of hair, covering the neck, body and upper part of the legs, leaving the head, belly and lower extremities short-coated. A tuft of hair extends from the top of the head into the forehead, occasionally covering the eyes. In the male the hair on the neck and chest may be elongated into a profuse mane. The beard is well developed in both sexes. The colour of the pelage is commonly black-and-white or black, more rarely brown with a black dorsal line. In conformation the long-haired type resembles the short-coated variety, both displaying a similar range of variation in size of body and length and shape of legs. However, there is one important difference: while the short-coated dwarf goat of eastern Congoland is generally plump and well furnished with muscle, but very poor in milk production, the long-haired type is usually lean and poorly muscled, while the milking qualities of the female are superior.

In his discussion of the domesticated animals of the interior of the Congo basin, Johnston (1907) comments that the goat of Congoland is the typical dwarf domestic goat of unadulterated negro Africa. Its general colour is fawn, with a dark brown or black line down the middle of the back, a dark brown forehead, blackish beard, and dark brown or black longitudinal stripes along the front aspect of the limbs. In its oldest and commonest type the coloration of the Congo goat reverts very much to that of the wild *Capra hircus,* even exhibiting sometimes the broad dark brown stripe on the shoulder of the males; but it nearly always develops a black instead of a white belly, a variation curiously paralleled in the domestic sheep of negro Africa. The horns are much reduced. In the male they are broad and set close together, and are very like those of the genus *Hemitragus.*

The goats of the Kosi of the Cameroons represent a typical example of disproportionate dwarfism. The sturdy body, well furnished with muscle, rests on disproportionately short

Male and Female Dwarf Goats and Kid from the Cameroons. After Hilzheimer.

legs, so that the withers height reaches only 45 to 50 cm. The head is very broad and short, and in some specimens clearly prognathous. The male carries broad horns of variable length, forming a homonymous twist. In the female horn growth is much weaker than in the male. Occasionally polled specimens may be encountered in either sex. About one-third of the Kosi goats are black in colour, some are black-and-white, a few brown, yellow or grey. These goats are never milked, and bred only for their meat which plays an important part in the cult of the pagans (Staffe, 1938).

The Hausa, centred in the region from Zaria to Katsina and Sokoto, keep a similar small and plump goat, which is distinguished by the heavy belly reaching down almost to the ground. The pelage of this breed is usually brown or black, black being the preponderant colour among the dwarf goats of the pagan tribes occupying the mountainous parts of Hausaland (Mueller, 1903).

Chang and Landauer (1950) hold that dwarf goats from different parts of Africa show a very similar body conformation. However, a comparison of the dwarf goats of the Cameroons with their heavy trunks and short thick legs with the slender-bodied, leggy dwarf goat from the Sudan shows that this view is erroneous, the African dwarf goats displaying a considerable degree of variability in type and conformation.

West African Dwarf Goat. After Klatt.

The goats of the coastal regions of West Africa belong to the well-marked dwarf type which ranges throughout the tropical parts of the Continent from the mouth of the Senegal to Somaliland. This goat is distinguished from other domestic breeds of the same family by its small size and plumpness. Unless half starved, it rarely shows the angular outlines of other domestic goat breeds. The original colour was probably a pale yellow-brown, deepening to black or lightening to white in the markings on the belly and limbs—in short, the coloration and markings of the wild *Capra hircus,* which in that respect it much resembles. But it frequently appears with a black, a white or a grey pelage, or may be mottled and blotched with black and white, or brown and white. Still, the coloration to which it reverts over and over again is strikingly like that of the wild Persian goat—yellowish brown deepening here and there to a bright bay on the upper parts, with a black tail, a black ridge of hair along the back, a blackish beard, a dark brown stripe down each shoulder, and black or brown stripes down the front edge of each limb, contrasting with white outer edges and inner side of the limbs and of the belly. But although resembling the ancestral goat in its typical coloration, this domestic goat of West Africa and the Sudan has very short horns, far shorter than those of the domestic goat of Europe. On the other hand, it is seldom found hornless, as is the case with some of the oriental breeds. From these it is sharply distinguished by its small erect ears which are never long and pendent as in the domestic goats of North Africa, Egypt and western Asia (Johnston, 1906).

In the majority of West African dwarf goats the horns are not scimitar-like, as the horns of *Capra hircus ægagrus,* but form a homonymous twist clearly discernible in spite of the shortness of the horns.

In Togo dwarf goats occur only at the coast, while the goats of the interior are of normal size. The dwarf goats of southern Togo reach hardly 50 cm. in withers height, and not more than 25 kg. in weight. They stand on short strong legs; both sexes carry short horns and a moderately long and thick coat, usually black and brown in colour interspersed with white spots, rarely red or yellowish brown or black throughout (Schrœter, 1914).

In Liberia the goat is not such a common domestic animal as it is, for example, on the Niger coast or throughout the southern third of Africa. It is more abundant in the interior than on the coast. It belongs to the same dwarf breed found in Central Africa and all along the west coast south of latitude 15°.

The goats on the west coast of Africa are characterized by the relatively large head. The horn cores are very broad at the base and directed backwards at an even distance. The horns are moderately long. Viewed from the front, they are often exceedingly wide, as their anterior edges are inflected inwards, so that the normally lateral surface of the horn is turned into the front surface. The inwardly directed frontal edge of the horn is conspicuously keeled, the keel ending cranially in a spur (Herre, 1943). The nasals are broad and straight, and the ears short and erect or semi-pendulous. The body is plump, the tail very short and commonly erect, the legs are short and thick, and the udder is poorly developed. The coat is short, and light yellow brown in colour with a dark dorsal stripe. The male is furnished with a long full beard and a ridge of elongated hair along the spine (Pierre, 1906).

Pituitary hypoplasia is defined as a general arrest of growth and development of all organs and systems of the body because of a hereditary hypo functioning of the growth principle of the anterior lobe of the pituitary (Engelbach, 1932). It has been shown by experiment that, if the anterior lobe of the pituitary is removed, an animal can continue to live but not to grow, unless anterior pituitary implantation is performed or anterior pituitary feeding instituted (Gardiner-Hill, 1943). Since neither sexular development nor general glandular constitution is affected, there seems to be an inherited deficiency in the secretion of merely the hormone controlling growth. This makes for an individual of short stature, but which is otherwise normally developed, proportionately built and of normal sexual development (Cameron, 1935). A typical example of this form of dwarfism is the slender-bodied Sudan goat.

Male and Female Dwarf Goats from Futa Jallon. After Pierre.

The Descent of the African Dwarf Goats

Dwarfism is the term applied to a collective concept comprising all individuals whose body size remains considerably behind the accepted average (Zondek, 1923). There are several types of dwarfism; some are predetermined by inheritance, others are the result of internal or external circumstances. True hereditary dwarfism is essentially an inherited characteristic dependent on chromosomal constitution. In the dwarf goats of Africa two different hereditary forms occur: pituitary hypoplasia and achondroplasia.

Generally the neurocranium is large in proportion to the splanchnocranium and to the body. However, this does not appear to be a primary disposition. Rather it seems to be connected with the fact that small animals have a relatively larger body surface and a more intensive metabolism than larger animals of the same species, resulting in correspondingly larger nerve centres in the brain and a larger brain case. The brain's relative growth-rate is high in early embryonic life; in domestic animals of ordinary size it later slows down markedly, and the high allometry of the face

then comes into play. But in dwarf domestic breeds facial allometry is checked early. There normally results not only a relative orthognathism, but also absence of cranial superstructure, persistent cranial sutures, rounded palate, smaller permanent teeth, often with simplified pattern, and relatively wide cranial cavity (brachycephaly) (Huxley, 1943).

Achondroplasia, the second type of hereditary dwarfism in Africa goats, is differentiated from pituitary dwarfism by the marked difference in bodily proportions. There is an average-size trunk coupled with abnormally stunted extremities. Achondroplastic goats, as typified by the dwarf goat of the Cameroons, are distinguished by the abnormality of cartilage bone formation arising in fœtal life, and resulting in a deficient growth of the long bones, causing dwarfism with long body but short limbs. It is generally agreed that achondroplasia is not endocrine in origin (Wolf, 1936).

The essential change is a defective cartilage bone formation due to abnormality of the epiphyseal cartilages. The line of ossification is straight but narrow, and the zone of cartilage cell-proliferation shows the cells irregularly arranged and scant in number. Connective tissue strands grow in from the periosteum, and sometimes separate the shaft completely from the epiphysis, resulting in some cases in delayed epiphyseal ossification, and in others in premature union. Formation of the periosteal bone, however, is normal.

which is nearly that of an ordinary goat, and the length of the legs which are stunted. The head appears enormous, with a prominent forehead and a marked depression in the region of the nasal roots. The humerus and femur are most affected, and the radius and tibia almost as much, causing the articulations of the joints occasionally to be set at abnormal angles. The same abnormality of position is frequently seen in the sacrum which is tilted downwards, causing contraction of the pelvis and a downward curvature of the spine. This condition appears to be prevalent in the dwarf goats of the Hausa, which, according to Mueller (1903), are distinguished by the very heavy belly reaching down almost to the ground. The buttocks are prominent, the genitals well developed, the hoofs large, and the gait is often waddling.

Achondroplasia is usually considered to be directly associated with the germ plasm. Evans and his associates have ruled out the possibility of pituitary involvement. They have injected daily a preparation of the growth principle, freed from the gonad-stimulating principle, into a number of dachshunds typifying achondroplasia. The animals increased greatly in size over the controls, gigantism being definite, but still retained the achondroplastic form of the short extremities (Cameron, 1935).

From their study of dwarf goat skeletons from northern Nigeria, Chang and Landauer (1950) conclude that the bones do not reveal

Male and Female Achondroplastic Dwarf Goats. After an etching by A. Bell (1726–1809).

The appearance of the achondroplastic goat is unmistakable because of the marked disproportion between the length of the trunk, any of the features typical of chondrodystrophy (achondroplasia), such as a shortening of the chondrocranium, increased width of the

shafts of the long bones or mushroom-shaped metaphyses; nor are there any of the distinguishing histological signs of chondrodystrophy, such as irregularity of the columns of cartilage cells or intensified periosteal ossification. Dwarfism in these goats represents a hereditary disturbance in which the extremities show only a slight degree of disproportionate shortening and the bone histology is normal.

The dwarf goats of northern Nigeria differ, therefore, from the achondroplastic dwarf goats of the Kosi of the Cameroons, which, as Staffe (1938) has pointed out, represent a typical case of disproportionate dwarfism.

Achondroplasia and pituitary hypoplasia are not always so unmistakably manifest as in the goats of the Cameroons and the Sudan respectively. Many of the dwarfed goat breeds of Africa represent transitional types in which pituitary hypoplasia and achondroplasia are combined, the former prevailing in some instances, the latter in others. These breeds, therefore, are characterized by the combination of two different factors: the one acting upon the pituitary, the other—to our present knowledge—direct upon the cartilage bone formation.

In few other parts of the world has hereditary dwarfism in goats been so extensively elevated to a breeding standard as in negro Africa. Three factors seem to account for this: natural selection, artificial selection, and inbreeding.

Poor environmental conditions, more especially a scarcity of grazing and the hot climate of the tropical rain forest, favour domestic animals of a diminutive size. For not only do the dwarf sanga cattle of Congoland and the dwarf shorthorns of the west African coastal swamps thrive there, but also the pygmy sheep, which is all the more remarkable as few other domesticated animals can endure moisture and forest country as badly as the sheep. A reduction in body size increases the surface area per unit volume or unit weight. The larger the surface area of the body, the greater is the rate of heat transfer by vaporization, convection, conduction and radiation. In hot regions where heat dissipation is difficult the adaptational evolutionary trend must be for the body to be small, so that the large surface per unit volume may permit the highest possible rate of heat dissipation (Brody, 1948). Under such conditions dwarf mutants are more highly adapted than the bulk of the ordinary stock, the pressure of selection bringing about a gradual alteration of the stock by the slightly higher survival and reproduction rate of dwarf types.

Owing to the breeders' experience of the greater hardiness and better condition of the smaller animals in their flocks, natural selection has, under adverse environmental conditions, doubtless been frequently supported by artificial selection of diminutive specimens for breeding purposes. As to the achondroplastic goat breeds of Africa, their peculiar appearance may have contributed to their owners' preference for them. Johnston's (1902) remark that in Busoga and eastern Uganda a breed of domestic goat is often met with that is prized for its strange appearance is significant in this respect.

As the native settlements in the rain forest belt may in some degree be likened to islands cut off from the introduction of new blood for lengthy periods, close and continual inbreeding held to explain the small body size often encountered in island fauna, may have been a contributory factor to the prevalence of dwarfed goat breeds in equatorial Africa, increasing the rate of combination of recessives governing pituitary hypoplasia and achondroplasia. Huxley (1943), however, does not mention this factor, but ascribes the evolution of dwarf forms on islands or near the limit of their range solely to selection in relation to the somewhat unfavourable conditions.

In discussing the origin of the dwarf goat commonly found among the cultivating peoples of Central and West Africa, Forde (1934) points out that this type has a much higher immunity to fly-borne diseases than has the large brown goat of the African savannas. While the Asiatic and African breeds of domestic goat are generally considered to derive from a single wild species (*Capra ægagrus*) which had formerly a very wide distribution in southern Europe and western Asia, the dwarf goat may be descended from a different and perhaps African ancestor.

However, in view of the absence in Africa of a true wild goat in the restricted sense (*Capra nubiana* and *Capra walie* being the only African representatives of the genus), the suggestion that the African dwarf goat may be descended from a hypothetical autochthonous wild species has no foundation. Johnston (1906) states that although the goat

of negro Africa has become such a dwarfed breed there is no doubt that it is a descendant of the Persian wild stock which first reached Egypt from Syria at a period of great antiquity. "The Egyptians on their own account appear to have domesticated the Nubian ibex (*Capra nubiana*) as well as the audad sheep. But these forms, like the ibex (*Capra waalii*) of the high mountains of Abyssinia, have left no domesticated descendants. The ancestor therefore of the negro's goat, as in the case of all his domestic beasts and birds, is an Asiatic animal." The dwarf goat, Johnston continues, no doubt was the first breed of true goat received by the ancient Egyptians, who passed it on to the land of the negroes up the Nile valley and across to Lake Chad before they received the greatly modified and specialized domestic breeds of goat associated at the present day with Egypt and the eastern Mediterranean region.

"It is very doubtful whether the ancient Egyptians ever penetrated directly up the Nile beyond the vicinity of Fashoda, or had any direct intercourse with Uganda, though their traders may have gone south-westwards towards the Bahr el Ghazal. Rather it would seem as though ancient Egypt traded and communicated directly with what is now Abyssinia and the Land of Punt (Somaliland), and that the Hamitic peoples of these countries facing the Red Sea and Indian Ocean carried a small measure of Egyptian culture into the lands about the Nile lakes. In this way, and through Uganda as a half-way house, the negro received his knowledge of smelting and working iron, all his domestic animals and cultivated plants, except those, of course, subsequently introduced by Arabs and Portuguese." (Johnston, 1902.)

Johnston's assertion that negro Africa received the dwarf goat from Egypt finds some support in the occurrence of the bones of this animal in the pre-dynastic deposits of Toukh, as well as in the representations of a similar goat on an ancient rock drawing at Assuan, the ivory knife handle from Gebel el Araq, and the carved mace head of Nar-mer.

But there is no lack of contradictory evidence, tending to show that both the ancient dwarf goat of Toukh and the recent dwarf goats of equatorial Africa—as far as they are pituitary dwarfs—may have been introduced from Somaliland where similar dwarf goats are found to this day.

Domestic goats can be traced in Egypt as far back as the Badarian age. Brunton and Caton-Thomson (1928) repeatedly refer to the role of the domestic goat in Badarian culture, the Badarians wrapped their dead in skins. "The kind of skin varied, in most instances it was probably goat"; "The dog, ox, sheep and goat are found wrapped in matting and even in linen"; and, "There was no scarcity of food; apart from herds of oxen, sheep and goats which we may suppose to have been domesticated game abounded". Nothing definite, however, is known about the type of goat bred in Egypt at the time of the Badarian culture and during the long interval that elapsed until the invasion of the dynastic people who according to Petrie (1939), were previously settled in the Land of Punt, where they had founded the island fortress of Ha-fun, commanding the whole of that coast. The dwarf goat seems to have appeared in Egypt before the dynastic conquest; but apparently it could not hold its own there against the screw-horned goat. There was much more vegetation then than now, and in a favourable environment a larger goat would be preferred to a dwarf.

A similar dwarf goat still occurs in Arabia, more especially in the province of Hejaz and the western parts of Nejd. The goats of Hejaz are of a remarkably uniform type, suggesting a long past uninfluenced by introductions of goats from other lands. Their outstanding characteristic is the small body size, the withers height rarely reaching 60 cm. The general conformation shows the harmonious proportions of the pituitary dwarf (Epstein, 1946).

There may be an ancient connexion between the pituitary dwarf goats of Hejaz and those of Somaliland. Both may be remnants of the migrations of the Pun people, not all of whom, as Petries (1939) says, went up the Red Sea coast to form the dynastic invaders of Egypt, some going on to Syria. But it is also possible that the Hejaz and Somali goats go back to even earlier waves of immigrants, the first pastoral folks that entered the Arabian peninsula and Somaliland long before the passage of the Pün people.

Were dwarfism in every goat breed of Africa due to pituitary hypoplasia only, the descent of all African dwarf goats, the ancient goat of Toukh and the dwarf goat of Arabia from a single source beyond the confines of Africa would have to be seriously considered. But some of the dwarf breeds in the rain forest belt are achondroplastic or partly

achondroplastic. Obviously their characteristic conformation evolved independently of the pituitary dwarfs of ancient Egypt and Arabia. And what is evident in the case of the achondroplastic dwarfs may hold also in some of the pituitary dwarf goats of equatorial Africa, especially in view of the fact that the dwarf breeds of cattle and sheep of negro Africa attained their diminutive stature likewise in the environment of the tropical forest belt.

Thus dwarfism in the goats of Africa may in some instances be the product of the environmental conditions obtaining in the rain forest belt, in others be introduced. Like many factors characteristic of domestication, dwarfism may arise under totally dissimilar conditions. Klatt and Vorsteher (1923) regard as the central problem of domestication, "the relatively small number and the similarity of the domestication features in the different kinds of domesticated animals, being in contrast to the almost unlimited number of environmental constellations to which the entirety of domestic animals in the whole world is, was or may yet become exposed".

Since hereditary dwarfism in African goats is obviously due to selection of recessives (at Davis, University of California, both achondroplastic and pituitary dwarfs were obtained in Jersey cattle through continuous inbreeding—Kelley, 1946), it may be expected to occur independently in other goats as well. And indeed, such pygmy goats are known in several parts of the world, as in India, Siberia and Lappland. They include also the turbary goat of the Swiss lake dwellers, which Stegmann von Pritzwald (1924) erroneously regards as a direct descendant of the African dwarf goat.

The turbary goat was an animal of very small stature. The main characteristic of its fossil remains are the slender horn cores which are generally more strongly developed in the male than in the female. They are situated in the prolonged plane of the forehead, forming but rarely an obtuse angle with the latter. Viewed from the front they appear quite straight and parallel. In accordance with the position of the horns, the cranial profile is dished rather than convex. The interior of the horn core is completely sinuous, with very few diploic walls. There is a number of vascular and cutaneous furrows on the outside (Duerst, 1904).

According to Ruetimeyer (1861), the turbary goat is distinguished by its slender, compressed and lens-shaped horn cores which are remarkably pointed at the tips and placed vertically upon the skull at a distance of 25 to 30 millimeters. In older males the cores become almost triangular in cross-section and very thick (Duerst, 1905). Augst (1920), however, in rejecting Duerst's description, states that he has never found a triangular core, the horn cores in the turbary goat always being pear-shaped with a sharp keel in front, that becomes rounded in aged males, in which the cores are therefore devoid of any keel on the lower third, and more, of their length.

According to Duerst (1905), skull fragments of the turbary goat, especially of the female, show a complete conformity with the skull of *Capra hircus cretensis.*

From our description of the African dwarf goats it is evident that many of these, be they pituitary or achondroplastic, differ from the turbary goat in the shape of the horn which is regarded by the majority of investigators as of specific significance. In some of the African dwarf goats the horns are scimitar-like as those in the turbary goat of Switzerland, the Hejaz goat and the dwarf goats of ancient Egypt; but in others they form a homonymous cone-like screw or a twist, curving at first backwards and outwards, and then bending forwards at the tips. This is confirmed by Hilzheimer (1926) from his study of African dwarf goats at the Berlin Zoological Garden, a confirmation carrying all the more weight since this author had originally (1916) classed all African dwarf goats with the goats carrying scimitar-like horns.

The profound differences in horn shape, character of coat and kind of dwarfism encountered among the dwarfed goat breeds of Africa indicate that various types of normal-sized domestic goats are involved in their genealogy.

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NOTES ON EAST AFRICAN APHIDS
I—SYNONOMY

By V. F. Eastop, East African Agriculture and Forestry Research Organization

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About 90 names are in use for the 50 or so species of aphids now known to occur in East Africa and some of these are referred to in economic literature under still other names. The purpose of this paper is to summarize the available information on the names of East African aphids as there has been no taxonomic work published about them since Theobald's 1914 to 1920 papers. Eighteen species not previously recorded from East Africa are included in the list and are indicated by an asterisk. Insect names regarded as valid are in large capitals, synonyms are in small capitals and host plant names are in italics.

Thanks are due to Mr. J. P. Doncaster of the British Museum for the opportunity to examine Theobald's collection of African aphids, to Dr. D. Hille Ris Lambers for the opportunity to examine his collection and for the gift of named material of many tropical aphids, to Mr. J. C. M. Gardner and Dr. E. Judenko for aphids collected by them in Kenya and to Mr. B. Verdcourt of the East African Herbarium for identifying many host plants for the author.

ACYRTHOSIPHON PISUM (Harris), synonyms MACROSIPHUM PISI (Kalt.) and M. ONOBRYCHIDIS (B. d. Fonsc.). Feeds mainly on *Leguminosæ*.

A. sp. * feeding on *Bidens pilosa* at Muguga, Kenya.

APHIS AFRICANA Theobald, probably synonomous with LONGIUNGUIS DONACIS (Pass.).

A. ASCLEPIADIS Pass. = A. NERII B. d. Fonsc.

A. BRASSICÆ L. = BREVICORYNE BRASSICÆ (L.).

A. CITRICIDUS (Kirkaldy) = TOXOPTERA CITRICIDUS (Kirkaldy).

A. COMPOSITÆ Theobald, described from an unknown Composite.

A. CRACCIVORA Koch. This is the correct name for African material previously determined as LABURNI and LEGUMINOSÆ. It is separable from the three closely related European species, LABURNI, Kalt., SAROTHAMNI Franssen and ULICIS Walker and is closest to SAROTHAMNI. The one large sample of this group seen by the author from America could not be separated from SAROTHAMNI.

A. FABÆ Scopoli feeds on many plants in Europe.

A. FICUS Theobald, described from *Ficus*.

A. GOSSYPII Glover, feeds on many plants, particularly *Malvaceæ*.

A. LABURNI Kalt., East African records apply to A. CRACCIVORA Koch.

A. LEGUMINOSÆ Theobald = A. CRACCIVORA Koch.

A. MAIDIS Fitch = RHOPALOSIPHUM MAIDIS (Fitch).

A. NERII B. d. Fonsc., a yellow aphid recorded from many plants.

A. POMI De Geer feeds on apple, *Cotoneaster* and related plants.

A. POMONELLA Theobald probably = A. POMI De Geer.

A. PRUNIELLA Theobald described from *Prunus*.

A. PSEUDOBRASSICÆ Davis = LIPAPHIS PSEUDOBRASSICÆ (Davis).

A. RUMICIS L. East African records probably apply to A. FABÆ Scopoli.

A. SACCHARII Zehntner = LONGIUNGUIS SACCHARII (Zehntner).

A. SOLANELLA Theobald described from *Solanum*.

A. SORGHI Theobald = LONGIUNGUIS SACCHARII (Zehntner).

A. TAVARESI Guercio = TOXOPTERA CITRICIDUS (Kirkaldy).

APLONEURA LENTISCI (Pass.)—sub-sp. GRAMINIS Buckton* from grass roots at Muguga, Kenya.

AULACORTHUM SOLANI (Kalt.) = AULACORTHUM VINCÆ (Walker).

A. VINCÆ (Walker), synonym MYZUS PSEUDOSOLANI Theobald, feeds on many plants.

BRACHYCAUDUS HELICHRYSI (Kalt.)* found on Compositæ at Muguga.

BREVICORYNE BRASSICÆ (L.), a mealy aphid feeding on many *Cruciferæ*.

CERATAPHIS LATANIÆ Boisd. recorded from many plants.

CERCIAPHIS BOUGAINVILLIÆ Theobald = SCHOUTEDENIA BOUGAINVILLIÆ (Theob.).

DACTYNOTUS SONCHI (Geoffroy) on *Sonchus* spp.

D. (UROMELAN) COMPOSITÆ (Theobald) on many *Compositæ* and some other plants.

ERIOSOMA LANIGERA (Hausm.), the wooly apple aphid.

GEOICA LUCIFUGA (Zehntner)* on grass roots at Muguga.

G. sp. recorded from *Gossypium* roots.

HYADAPHIS CORIANDRI Das.* A single alata of apparently this species has been taken at Muguga.

HYPEROMYZUS LACTUCÆ (L.)* on *Sonchus oleraceus*. at Muguga, Kenya.

H. OLERACEÆ (van der Goot)* specimens collected from *Sonchus oleraceus* at Kawanda, Uganda, fit the description of this species and differ in some ways from LACTUCÆ L., but it is thought probable that when a greater range of material has been studied, OLERACEÆ will prove to be a synonym of the latter.

IDIOPTERUS NEPHRELEPIDIS Davis* on cultivated ferns at Mombasa.

LIPAPHIS PSEUDOBRASSICÆ (Davis), a green aphid on *Cruciferæ*.

LONGIUNGUIS DONACIS (Pass.), grass feeding.

L. SACCHARII (Zehntner) feeding on *Saccharum, Sorghum* and related cereals.

MACROSIPHONIELLA BEDFORDI Theobald = M. SANBORNI (Gillette).

M. CHRYSANTHEMI Guercio = M. SANBORNI (Gillette).

M. SANBORNI (Gillette) on Chrysanthemums.

MACROSIPHUM ANTIRRHINUM Macchiati, East African records apply to AULACORTHUM VINCÆ or MYZUS PERSICÆ.

M. BRACHYTARSUS H. R. L. = M. (SITOBION) NIGRINECTARIA (Theobald).

M. CISSI Theobald, in the sub-genus SITOBION Mordwilko.

M. COMPOSITÆ Theobald in DACTYNOTUS Raf. sub-genus UROMELAN Mordw.

M. DAHLIAFOLII Theobald = DACTYNOTUS (UROMELAN) COMPOSITÆ (Theobald).

M. EUPHORBIÆ (Thomas). The oldest name in the complex which includes M. SOLANIFOLII, feeding on many plants.

M. GEI (Koch). East African records apply to M. EUPHORBIÆ (Thomas).

M. GRANARIUM (Kirby) = M. (SITOBION) FRAGARIÆ (Walker).

M. LOPHOSPERMUM Theobald = MYZUS PERSICÆ (Sulzer).

M. LYCOPERSICUM Theobald = MYZUS PERSICÆ (Sulzer).

M. NEAVI Theobald. Described from the larvæ of DACTYNOTUS sp. and probably best regarded as a nomen dubium.

M. NIGRINECTARIA Theobald in sub-genus SITOBION Mordwilko.

M. PISI (Kalt.) = ACYRTHOSIPHON PISUM (Harris).

M. ROSÆ (L.). Only known from *Rosa* in East Africa where both green and pink forms are present.

M. ROSÆFOLIUM Theobald = RHODOBION POROSUS (Sanderson).

M. SOLANIFOLII (Ashmead) a member of the M. EUPHORBIÆ complex.

M. SONCHI (L.) = DACTYNOTUS SONCHI (Geoffroy).

M. (SITOBION) CISSI Theobald feeding on vines. This aphid and M. (S.) NIGRINECTARIA have the dorsal abdominal pigmentation of the alatæ, chætotaxy of the first instar larvæ and the short antennal hairs in the apteræ of SITOBION but the adult apteræ have an unpigmented dorsum and also differ from SITOBION as more usually understood in their biology.

M. (S.) FRAGARIÆ (Walker) known only from grasses in East Africa.

M. (S.) NIGRINECTARIA Theobald, feeding on *Cajanus indicus*.

M. (S.) spp., probably several undescribed species, all grass feeding.

METOPOLOPHIUM sp.* on *Bromus carthariticus*. at Muguga, Kenya.

MICROMYZUS PTERISOIDES (Theobald) on ferns.

MYZUS ORNATUS Laing* found only on *Conyza volkensii* and *Sanguisorba officinalis* at Muguga and Njoro in Kenya but in Europe feeding on many plants.

M. PERSICÆ (Sulzer), feeding on many plants.

M. POROSUS Sanderson, in RHODOBION, Hille Ris Lambers.

M. PSEUDOSOLANI Theobald = AULACORTHUM VINCÆ (Walker).

M. PTERISOIDES Theobald, in MICROMYZUS van der Goot.

NEOPHYLLAPHIS PODOCARPI Takahashi* on *Podocarpus gracilior* at Muguga. (leg. J. C. H. Gardner.)

NEOTOXOPTERA VIOLÆ (Pergande)* feeding on violets but so far only known from Muguga, Kenya, from one trapped alata.

N. VIOLÆ Theobald = N. VIOLÆ (Pergande).

PENTALONIA NIGRONERVOSA Coquerell* on *Musa.* from Kawanda, Uganda, and Urambo, Tanganyika.

RHODOBION POROSUS (Sanderson) on roses.

RHOPALOSIPHUM CARDUELLINUM Theobald = MYZUS PERSICÆ (Sulzer).

R. *dianthi* Schrank = MYZUS PERSICÆ (Sulzer).

R. MAIDIS (Fitch) on *Cynodon, Sorghum, Setaria* and *Zea.*

R. VIOLÆ Essig 1909 = NEOTOXOPTERA VIOLÆ (Pergande).

SALTUSAPHIS sp.* on *Cyperus rigidfolius* and *C.* (*Kyllingia*) sp. at Muguga.

SCHIZAPHIS GRAMINUM (Rondani) on wheat and wild grasses.

S. ? CYPERI (van der Goot)* on *Cyperus* sp. and *C.* (*Kyllingia*) sp. at Fourteen Falls and Muguga, Kenya.

SCHOUTEDENIA BOUGAINVILLIÆ (Theobald) from *Bougainvillea.*

TOXOPTERA AURANTII (B. d. Fonsc.) recorded from many plants.

T. CITRICIDUS (Kirkaldy) feeding on *Citrus.*

T. COFFEÆ Nietner, probably a synonym of T. AURANTII (B. d. F.).

T. CYPERI van der Goot, better placed in SCHIZAPHIS Börner.

T. GRAMINUM (Rondani), better placed in SCHIZAPHIS Börner.

TETRANEURA HIRSUTA Baker* on grass roots at Muguga, Kenya; Kawanda, Uganda, and Urambo, Tanganyika.

UNIPTERUS PAPILLATA Hall* on *Combretum* spp. at Fourteen Falls, Kenya, and Urambo, Tanganyika.

U. sp.* on *Commiphora zimmermani* at Nairobi.

YAMATAPHIS RHODESIENSIS Hall* on grass roots at Kawanda, Uganda.